THE PROCEEDINGS AND TRANSACTIONS of the NOVA SCOTIAN INSTITUTE OF SCIENCE

session of 1890-91. Second Series Vol. 1. Part 1. = (v. 8 of 1st ser.)

THE PROCEEDINGS AND TRANSACTIONS

OF THE

Nova Scotian Institute of Science,

HALIFAX, NOVA SCOTIA.

SESSION OF 1890-91.

SECOND SERIES.

VOLUME I. PART I.

The First Series consisted of the Seven Volumes of the Proceedings and Transactions of the Nova Scotian Institute of Natural Science.

HALIFAX, N. S.:
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CONTENTS.

SESSION OF 1890-91.

ANNUAL BUSINESS MEETING.

Halifax, 8th October, 1890.

PROF. J. G. MACGREGOR, *President*, in the chair.

The minutes of the last annual meeting were read and approved.

The PRESIDENT addressed the Institute as follows :—

Gentlemen,—I rejoice that one of the duties which is laid upon me by the regulations of the Institute to be performed at this meeting, viz, to give a sketch of the life and scientific work of members deceased during the year, is this year so very light. We have lost none of our members by death since last annual meeting.

The Institute has not only retained all its old members. It has also had an unusually large number of accessions. An addition of nine has been made to the list of our corresponding members, and there have been proposed and approved as ordinary members or associate members, thirty-four. A comparatively small number of the latter, not many more than half, have qualified for membership by payment of the annual fee. But I believe that is due to their not having received notice of the approval of their proposed membership by the council, through some defect in our arrangements. I am happy to say that among the new members there are quite a number who are likely to add very materially to the working strength of the Institute.

Though thus somewhat increased, our membership is nevertheless but little if any greater than it was in 1864, and it should be our aim to add to it to a very large extent. We ought to have on our list the name of every man in Nova Scotia who has the ability to make additions to our knowledge, and the names of all those besides, who, though they may not have the opportunity or the requisite preparatory training to enable them to advance science themselves, are willing to encourage others in their efforts by their interest and their annual fees.

So far as numbers of scientific communications are concerned, the past session has been a very successful one. Sixteen papers were submitted to the Institute, some of them of much interest and value. They were distributed as follows, four in the department of Geology, three in Zoology, one in Botany, one in Chemistry, four in Physics, one in Engineering and two of a biographical character.

It will thus be seen that the scope of the Institute's work has got beyond the range of the departments of science indicated by its name. And this fact applies to other recent sessions as well as that which terminates to-night. Thus in 1889-90 the following papers were communicated :—three in Geology, four in Zoology, two in Physics, and two in Archæology.

This tendency in our work to widen in its subject-matter has led us to consider the desirability of modifying our name so as to make it indicate the full scope of the Institute's exertions. The old name Institute of Natural Science had given rise to the impression that the society was intended to be a society of naturalists, and tended to repress the interest which men engaged in other departments of work might have taken in it. At the same time it was found to hamper us in our endeavour to secure by exchange the publications of other societies, societies of naturalists being always ready to exchange with us, but those devoted to departments not usually included under the term Natural Science requiring usually to have it specially explained to them that our work was wider than our name indicated. It was felt that as there was no other society in the Province of a scientific kind, our Institute ought to extend its field to all departments of science, pure and applied, and thus both encourage research in all such departments and build up, by exchange, a library for the use of those engaged in them. And, therefore, at a special meeting of the Institute, called for the purpose, during the past session, we resolved that our society should henceforth be known as the Nova Scotian Institute of Science. And we hope that while in the future those departments of natural science which we have cultivated in the past most assiduously, may be studied to a still greater extent, other departments for which we have so far done little or nothing, may also receive earnest attention. The number of our scientific workers in all departments is but small, and it cannot but be beneficial that we should be banded together and be enabled thereby to secure the stimulus which springs from a sympathetic, even though not a wholly intelligent, interest.

While we have been enlarging our membership and providing for the extension of the region of our activity, we have also been making exertions during the past year to provide our members with one of the most necessary means of research, viz., books. Since our last annual meeting, besides sending copies of our last issue of Transactions to the societies already on our exchange list, we have sent them to 300 other societies, museums, and other institutions, accompanied by circulars and letters, stating the nature and circumstances of our Institute and proposing an exchange of publications. In the case of the societies already on our list we have asked them to complete our sets of their publications, in order that we might bind them up and make them more readily available. And in the case of many of the other societies we have proposed an interchange of earlier publications as well as of those issued in future. This effort to add to our library a large portion of the most valuable part of scientific literature, the Transactions

of learned societies, has been exceedingly successful. Many of the societies which have been corresponding with us for many years have done what they could to complete our sets of their publications; so that we now possess many whole series of such publications, in some cases entirely, and in many practically perfect. Of the 300 new institutions requested to exchange with us, a large number have already complied, and additional acceptances of our proposal are being received by every foreign mail. Only three have refused, two being societies devoted to subjects which our former name seemed to exclude from the range of our activity, and one a society having no publications available for exchange. Many of these societies have sent us their publications for several years back as well as those for the current year, we, of course, sending them our back publications in exchange. The influx of publications has been so large that our bills for book-cases during the past year have been as great as in the whole past history of the Institute, and the work of receiving, registering and arranging has been a severe tax on the time of the members of the Council who have volunteered to do it.

The additions thus made to our library vary of course in value, but all are of some value, and some are of the very highest value as works of reference for the use of men engaged in research in the subjects of which they treat. The subjects are for the most part restricted to the natural and physical sciences, for we have not thought it wise to ask societies to exchange with us, which were devoted to subjects not represented in our Transactions. But already we have on our list societies devoted to such applied sciences as mining, engineering, mechanical arts generally, medicine and agriculture.

I am glad to have this opportunity of expressing our appreciation of the generosity with which British and foreign societies, but especially foreign societies, have responded to our appeal. Our own publication is a very modest one, but in exchange for it we receive, in a great many cases, works of far greater magnitude and cost and scientific value. They might fairly have replied that the exchange we proposed was an unfair one, that we could not give a *quid pro quo*, but with true liberality they send us their weighty volumes in the hope that they may aid in stimulating scientific research in our Province.

Encouraged by the success which has attended our efforts to build up a scientific library, we have become more ambitious during the year, and when the time came to make arrangements for the publication of the Proceedings and Transactions of the past session, the council decided to strike off 1000 copies, and to endeavour to effect exchange relations with all important societies everywhere. To carry out this scheme, however, our income was not sufficient. We accordingly laid our plans before the local government, pointing out the great importance of a scientific library to the development of the resources of the country, and asked an increase of our annual grant. We were met in the most liberal spirit. The members of the government shewed a keen appreciation of the importance of what we aimed at, and an addition of $100 was made to our usual grant. Thus increased, we hope our income will be sufficient to enable us to make our own Transactions more valuable by the provision of lithographed plates when they are necessary for illustration, and to cover the cost of transmitting our publications to corresponding societies, and of binding up and rendering otherwise available for use what we may receive in return.

With our library thus rapidly growing, the unsatisfactory character of our present quarters has become more and more apparent. As we are at present situated it is impossible to make our library available for public use, and even our own members have great difficulty in gaining access to it. Accordingly, by resolution of the Institute, a number of its members have co-operated with the Directors of the School of Art and Design and other leading citizens, in an effort to secure a building to afford accommodation for the collections of the Provincial Museum, the class-rooms and collections of the Art School and the libraries of the Legislature, the city, and local societies. It is to be hoped that the effort may be successful. For the increased utility of our libraries which would result from their consolidation, the immense benefit which the museum, if properly arranged, would confer upon the public, and the enlarged efficiency which the Art School would derive from suitable class-rooms, all make this effort one to which all good citizens should lend a helping hand. But whether this scheme be carried out or not, it is certain that our library cannot remain where it is very mnch longer at its present rate of growth. We must very soon obtain accommodation for it somewhere else, unless, indeed, the books are to be packed away as they arrive to await a more convenient season for beiug used. Even if that had to be done it would be well for us to continue in our present course and secure them now when they may be had. But how much better it would be if we could deposit them on arrival where they would at once be available for the use both of our members and of the public generally.

In addressing you on a former occasion I pointed out the advisability of our organizing some forms of collective scientific work, which would be rendered possible, were we able to extend our membership to a sufficient extent and secure a corps of competent observers scattered over the Province, who would make observations on various matters to which their attention would be drawn by printed circulars, and would transmit their observations to our Secretary, to form the material for reports. It was my intention to address you this evening on the methods by which such forms of work are carried on in other societies, but as the subjects which may be investigated in this way, such as the migration of birds, the geographical distribution of species in the Province, &c., lie to a large extent outside the only department of science of which I have any knowledge, I concluded that it was wiser not to attempt to discuss any such subject myself. Accordingly I brought the matter to the notice of the Royal Society of Canada at its last meeting and secured the appointment of a Committee of Biologists and Geologists, with instructions to report on the subject, and to draw up schedules of questions to serve as guides in the making of observations of the kind referred to. This course has the manifest advantage that it secures uniformity of action on the part of our local societies throughout Canada. If the scheme is systematically carried out it will probably lead to the accumulation of a large mass of valuable information, which, when systematized and condensed, may lead to results of scientific importance. While we are waiting for the report of this Committee, we ought to be preparing to carrying out its recommendations by extending our membership so that we may have on our list all persons throughout the Province who are able and willing to make such simple observations as would be required. If our present members would send me the addresses of such persons

with whom they may be acquainted, I would gladly forward them copies of our Laws and endeavour to induce them to join our Institute.

At the meeting of the Institute, during the last session, at which we decided to change our name, we resolved further to take steps to secure an Act of Incorporation. The Council accordingly had such an Act drawn up, and through the kindness of Dr. A. Haley, M. P. P., Chairman of the Committee on Private Bills, it was passed through the Legislature without expense to the Institute. According to that Act the members of the Institute are incorporated under the name of the Nova Scotian Institute of Science, and the incorporated Society is to hold its first meeting at the termination of the present meeting of the unincorporated Society. According to the Act it will be necessary for the unincorporated Institute to resolve formally to transfer all its property to the incorporated Institute; and a resolution to that effect will be submitted to you after the adoption of the usual reports. As this Act enables us to hold property in due legal form, let us hope that some of our public-spirited citizens may give us the opportunity of exercising our new powers, by establishing a Prize Fund to stimulate researches which would assist in developing the resources of the Province, or a Library Fund to enable us to purchase scientific works necessary for research which cannot be secured by exchange, or an Apparatus Fund to provide our observers with instruments which are too costly for individual workers to purchase for themselves. If we had even small funds for these purposes we might very much increase the working power of the Institute.

Even without them, however, we may hope that the present session will not lag behind its predecessors in the amount of the Institute's contribution to scientific knowledge. By doing what we can without such funds we shall establish our right to be entrusted with them.

The Treasurer submitted his report which was adopted.

On motion of Mr. A. McKay and Dr. Murphy the following resolution was passed:—

Resolved, That all the property and assets of the Nova Scotian Institute of Science, unincorporated, be transferred to the Nova Scotian Institute of Science, incorporated, and that all right and title to said property and assets be hereafter vested in said Nova Scotian Institute of Science, incorporated.

The Institute then adjourned *sine die*.

HALIFAX, 8th Oct., 1891.

The first meeting of the corporators of the Nova Scotian Institute of Science was held to-day, according to the provision of the Act of Incorporation. Prof. MacGregor was called to the chair and Mr. A. McKay appointed Secretary.

The chairman read the Act of Incorporation as follows:—

AN ACT TO INCORPORATE THE NOVA SCOTIAN INSTITUTE OF SCIENCE.

(Passed the 15th day of April, A. D. 1890.)

Whereas, the society formerly known as the Nova Scotian Institute of Natural Science was organized in the year 1862;

And whereas, said society did in the present year, 1890, change its name to "The Nova Scotian Institute of Science;"

And whereas, the members of said society are desirous of becoming incorporated under said name;

Be it enacted by the Governor, Council, and Assembly, as follows:

1. The president and members of the society now known as the Nova Scotian Institute of Science, their successors and assigns, are created a body corporate by the name of "The Nova Scotian Institute of Science."

2. The object of said body shall be the promotion of scientific research, and it shall have power to buy, hold, lease or sell real estate to the value of $50,000, and may borrow or lend money.

3. It shall also have power to make by-laws regulating its membership, officers, and the management of its business generally, provided such by-laws are not contrary to any general law of the province.

4. All the property of the society known as "The Nova Scotian Institute of Science," shall become the property of the body hereby incorporated, so soon as said society, at a meeting called for that purpose shall, by a two-thirds vote of its members present, pass a resolution approving of such transfer of its property.

5. The said corporators may hold their first meeting on the second Wednesday of October, 1890, on which day this Act shall come into force, and may transact at such meeting any business arising under the powers hereby conferred on them.

On motion of Messrs. A. McKay and M. Bowman, the Laws of the Nova Scotian Institute of Science (unincorporated) were adopted as the laws of this Institute.

The following were then elected members of Council for the ensuing year:—

President—PROF. J. G. MACGREGOR, D. SC.
Vice-Presidents—MARTIN MURPHY, D. Sc., C. E., and J. SOMERS, M. D.
Corresponding Secretary—A. H. MACKAY, B. A., B. Sc.
Recording Secretary—ALEXANDER MCKAY.
Treasurer—WM. C. SILVER.
Librarian—M. BOWMAN.

Councillors without office:—Prof. G. Lawson, LL. D., E. Gilpin, Jr., A. M., F. G. S., F. W. W. Doane, C. E., R. J. Wilson, Augustus Allison, D. A. Campbell, M. D., and Principal O'Hearn.

ORDINARY MEETING, Province Building, Halifax, 10th November, 1890.

The PRESIDENT *in the Chair.*

Inter alia.

The President read a paper by Prof. L. W. Bailey, Ph. D., entitled: Notes on the Surface Geology of South Western Nova Scotia. (See Transactions, p. 1.)

Rev. M. Maury, D. D., of Waltham, Mass., called attention to a new process in telegraphy and explained the nature of it.

ORDINARY MEETING, Province Building, 8th Dec., 1890.

The PRESIDENT *in the Chair.*

Inter alia.

Mr. E. Gilpin, Jr., communicated a memorandum of Experiments on Building Stone from Nova Scotia, made for Mr. H. G. C. Ketchum, of the Chignecto Ship Railway, by Mr. N. E. Cooper. The specimens of stone experimented on were two (Nos. 1 and 2) from Grindstone Quarry, near Joggins in Chignecto Bay, intended for use at Amherst Dock, and two (Nos. 3 and 4) from Gulf Shore, near Pugwash, Northumberland Strait, 6 to 8 miles from Port Philip, intended for use at Tidnish Dock, and being used at the 30 ft. arched bridge at Tidnish River. Nos. 1 and 2 had been rubbed with sand; Nos. 3 and 4 finished with the fine chisel only.

"The first piece of stone experimented upon was No. 3 from Gulf Shore Quarry. It was placed between pitch pine boards 1 inch thick, and the pressure in the large ram put on; when it had reached 34 tons per foot the stone cracked vertically 1½ inches from the edge. Thinking that it might not have been put upon its natural bed, it was again put in with the face at right angles to the former uppermost, and, on applying the pressure of 34 tons per foot, it cracked on both sides parallel to the vertical faces at about the same distance from them as in the first case.

"In order to test whether there was any unequal strain upon the specimen a half brick was tested under precisely similar conditions. This cracked with a pressure of 53 tons per square foot and crushed at 150 tons per square foot.

"The appearance of the pitch pine board seemed to indicate unequal pressure. Similar pieces of yellow pine were then procured.

"The specimen No. 1 from Grindstone Quarry was then tried, with the result that at a pressure of 600 tons per sq. foot the corners began to chip, the yellow deal packing being reduced in thickness to about ¼ inch. The specimen was then removed as it appeared to be subject now to unequal strains.

"The companion specimen No. 4 to No. 3, from Gulf Shore first experimented upon was then tried between yellow pine boards, and failed by splintering on the edge, the pressure being 228 tons per sq. foot.

"Specimen No. 2, the companion to No. 1, was not tested."

The President read a paper by Mr. D. W. Robb, of Amherst, N. S., on "Steam Boiler Tests as a means of determining the Calorific Value of Fuels." (See Transactions, p. 9.)

The President read extracts from a letter received from Mr. R. Balfour Brown, of Yarmouth, as follows:—

"I send you two small boxes containing samples of ores from Port Gilbert, in Digby Co.

"Among the samples you will find some pieces of pudding stone, well spotted, and indeed *saturated* with paraffin tallow. A piece of the tallow, on having a blaze from a blowpipe applied to it, burned like a squib until it was consumed; it soon, however, loses its gaseous element and becomes much less inflammable.

"I presume sulphuric ether would decompose this substance, but I have attempted no test of itself or the gangue.

"Not having seen any mention made in any of the annual reports from Mr. Gilpin, I thought it might interest you should it prove to be rare.

"I have added to the above a sample or two from a sedimentary deposit of manganese, and a red sienna from a 12 inch vein running into the solid ledge at Gilbert's Point.

"The black oxide of manganese is covered by about three inches of soil, and in itself forms *two* strata with an *inter-stratum* about 4 inches thick of the yellow deposit, of which I send you a sample. The whole bed is nearly 3 ft. in thickness. By rubbing these substances between the finger and thumb, first moistening them, until the water evaporates, you will observe that they are completely saturated with a natural oil; and this I have little doubt is petroleum.

"While stopping a few days in August last at this locality I noticed that some of the wells were impregnated with this gaseous substance, and, indeed, under certain atmospheric conditions, the very air was tainted with the unmistakable odour of kerosene."

The specimens referred to were exhibited.

ORDINARY MEETING, Province Building, 19th January, 1891.

The PRESIDENT *in the Chair.*

Inter alia.

Rev. G. Patterson, D. D., read a paper on "The Magdalene Islands." (See Transactions, p. 31.)

In the discussion on this paper, Principal A. H. MacKay referred to a holiday natural history exploration of the Magdalene Islands made in July and August, 1878, by himself and his brother, the late John H. MacKay, with geological hammer and knapsack, botanical vasculum and gun. Nearly all the coast line of the islands, Amherst, Grindstone, Alright, Coffin, Old Harry Head, Northeast Cape, North Cape, Grosse, and Wolf, with most of their connecting sand bars were tramped on foot; and several excursions were taken through the interiors. He recognised the graphic word pictures of Dr. Patterson, and referred to a few additional interesting points. About one hundred and seventy phænogamous, with a large number of cryptogamous plants, were observed. Among interesting ones, *Rubus chamæmorus*, on a transformed sand bar, near Wolf Island, *Parnassia*, on a rocky islet near Coffin Land, *Habenaria orbiculata*, in a fair hill-sidewood, might be mentioned—perhaps chiefly on account of the dramatic interest of the occasions of the discoveries.

Geographically, these islands were practically in three groups, forming a chain running northeasterly as was described. The southern, Amherst, running east and west about nine miles, south to north, three or four miles, was apparently on a due east and west anticlinal of gypsiferous rock, through which ridges and conical elevations of igneous (doleritic) rocks rose, forming Demoiselle Hill abutting on the coast nearly 300 feet high, and rising in the interior to nearly double that altitude. These were considered to be of lower carboniferous age. On each side of this anticlinal the dip was respectively north and south, first reddish and grayish strata of various sandstones, then on the south and north coast a redder sand-

stone like the Permian or Triassic. Near the Demoiselle hills we saw splendid demonstrations of the manner in which pits are produced in gypsum regions. Veins were found running out to the coast. By the solution of these in water, cavities were formed, and eventually the superincumbent earth fell in. We saw natural trenches thus made, apparently showing each spring's work, and we investigated some quite fresh falls, on lines going pretty far inland. At this fine exposure of the igneous rocks the jointed and crumbling rocks show in many places coatings of small crystals of silica, but some were nearly an inch long and a half inch in diameter, perfectly hexagonal, but more or less ferrúginous. The crystals were commonly mingled with or replaced by beautiful glistening crystals of specular iron. In the same region also fragments of stone with manganese deposits were noticed. Gypsum was found sometimes crystallized as pure selenite, often as white, orange, grey, banded and party-colored gypsum; but most often as fibrous gypsum, the fibres running from one wall of the vein to the other. Amherst island sends out northeasterly two huge armlike sand bars seven or eight miles long, enclosing a salt lagoon three or four miles broad in some places, which clasp Grindstone island by its two southern red sand stone ears. Through this island a similar anticlinal runs nearly parallel to the former, but nearer the northern coast than the southern. The doleritic knolls and ridges rise in the interior to over 600 feet probably. The gypsum bearing rocks are closely associated, then the coarse and variegated sandstones, and farther off still, red soft sand stone rises in perpendicular and picturesquely scored cliffs over the sea, in some places perhaps a hundred feet high. Towards the anticlinal some impure limestone bands were observed, and crops of calcite crystals were knocked off some rocks. Grindstone island, like its southern neighbor Amherst, tried to extend its two arms of sand bars 20 or 25 miles to the northern group. But the eastern arm is broken at the beginning by the entrance to House Harbor, and the part cut off is a respectable island—Alright, with high sandstone cliffs to the sea, with the doleritic knolls and gypsiferous surroundings which form a part of the system of the neighboring island. From Alright the arm extends to the northern entrance to the long, shallow, bar-bounded sea, and ends opposite Coffin island. The western bar extends in a straight line for nearly twelve miles to the red-sandstone cliffed Wolfe's islet, which is like a sesamoid bone in the middle of a muscle of sand nearly 24 miles long—connecting Grindstone with Grosse Isle, and the chain similarly connected sweeping around the north to Coffin's Land. In this northern group, the higher red sandstone was observed, and the lower sandstones, and at one place signs of gypsum deposits; and at the northern capes strata of some impure limestones which were not higher than the gypsum beds probably were observed. Between Old Harry Point, where Neptune often raises the old man in columns of thundering spray spouting up the channeled sandstone cliffs, and East Cape, the ocean in full swing falls upon a regular bay-like curve of several miles, where the beach is of the most beautiful sand, sloping up gently and evenly from the pounding surf for about 80 yards. Then there is a nearly perpendicular wall of sand averaging perhaps 20 feet in height, then a second rampart 5 or more feet high, from which there is a rapid slope inland to a low region of undulating sand hills covered with *Empetrum*, *Vaccinium*, *Hudsonia*, *Spartina*, &c., and stunted bushes. This wall, extending for miles, looked

as distinctly mural and regular as if it were the work of man. Here was a great Chinese wall of sand, with the proof before us that the builders were known only to the sea, the wind, and the rush-like grasses.

A. P. Reid, M. D., Superintendent of the N. S. Hospital for the Insane, read a paper entitled: "Poverty Superseded, or a new Political Economy."

ORDINARY MEETING, Province Building, 9th Feb., 1891.

The PRESIDENT *in the Chair.*

Inter alia.

Prof. G. Lawson read a paper entitled: Notes for a Flora of Nova Scotia, Part I. (See Transactions, p, 84.)

Mr. John Forbes read a paper entitled: Remarks upon the coating of iron with magnetic oxide, and a suggestion of a probably new method of producing it. (See Transactions, p. 27.)

ORDINARY MEETING, Province Building, 9th March, 1891.

The PRESIDENT *in the Chair.*

Inter alia.

The President read a paper by Mr. E. Gilpin, Jr., entitled: Analyses of Nova Scotia Coals and other minerals. (See Transactions, p. 19.)

The President read a paper by Mr. W. B. McKenzie, C. E., entitled: Notes on Railroad Location and Construction in Eastern Canada. (See Transactions, p. 111.)

On motion of Principal MacKay and Mr. M. Bowman, the following resolution was passed:

Whereas, we learn that the Geological Survey of the counties of Antigonish and Pictou has been completed in such detail as cannot be adequately represented on maps drawn to the proposed scale of four miles to an inch;

Resolved, that the Council be instructed to petition the Government to publish the maps of these counties as soon as possible, and on a scale of not less than one mile to an inch, the scale on which the survey of the Cape Breton counties has been published.

ORDINARY MEETING, Provincial Museum, 13th April, 1891.

The PRESIDENT *in the Chair.*

Inter alia.

Prof. H. W. Smith read a paper entitled: Fertilizers on Sandy Soil. (See Transactions, p. 122.)

The President communicated a paper by Mr. A. M. Morrison, entitled: On the variation with concentration of the density of dilute solutions of Cobalt and Nickel Sulphates. (See Transactions, p. 132.)

The President read a paper entitled: On some lecture experiments illustrating properties of saline solutions. (See Transactions, p. 71.)

ORDINARY MEETING, Provincial Museum, 18th May, 1891.

The PRESIDENT *in the Chair.*

Inter alia.

Principal A. H. MacKay read a paper entitled : Pictou Island. (See Transactions, p. 76.)

The President read a paper entitled : A simple proof of the completeness of the differential, dH/T, in thermodynamics.

Mr. E. Gilpin, Jr., read a paper entitled: Notes on some explosions in Nova Scotian Coal Mines. (See Transactions, p 58.)

Mr. E. Gilpin also communicated a memorandum by Mr. H. G. C. Ketchum, of the specific gravities and percentages of absorption of specimens of building stone supplied to the Chignecto Ship Railway, as follows:—

CHIGNECTO MARINE TRANSPORT RAILWAY.

Specific Gravities, &c., of Building Stone.

NAME OF STONE.	Weight in Air.	Weight in Water.	Specific Gravity.	Weight in Air when Saturated.	Percentage of Absorption.
Joggins, N. S..................	540	324	2.50	562	4.07
Seaman, Joggins, N. S..........	644	383	2.47	673	4.50
A. E. Beaton, 6 m. from Tidnish..	254	155	2.56	263	3.54
McKelvey, Dorchester, N. B.....	598	366	2.58	617	3.16
Hagun's Cape, Maranquin, N. B..	955	564	2.44	972	1.80
Port Philip, N. S...............	870	535	2.60	889	2.18
"	750	450	2.50	768	2.4
Wallace, N. S..................	805	478	2.46	834	3.60
Joggins (High) N. S.............	832	493	2.45	866	4.09
Springhill, N. S................	753	446	2.45	785	4.25
Curran, N. S...................	844	500	2.45	883	4.62

ALEXANDER MCKAY,
Recording Secretary.

LIST OF MEMBERS.

ORDINARY MEMBERS.

Name	Date of Admission.		
Allison, Augustus, Halifax	Feb	15,	1869.
Bayers, Rufus, Halifax	March	4.	1890.
Bennett, Joseph	Nov.	3,	1886.
Bliss, D. M. Electrician, Amherst	Jan.	31,	1890.
Bowman, Maynard, Public Analyst, Halifax	March,	13,	1884.
Brown, C. E. Halifax	Dec.	20,	1864.
Brown, R. B., Yarmouth	Jan.	10,	1891.
Butler, Prof. W. R,, King's College, Windsor	Nov.	27,	1889.
Campbell, D. A., M. D., Halifax	Jan.	31,	1890.
Campbell, G. M., M. D., Halifax	Nov.	10,	1884.
Coates, Col	April	1,	1887.
Clements, E. F., Yarmouth	Jan,	10,	1891.
Denton, A. J	April	13,	1884.
DeWolfe, J. R., M. D., L. R. C. S. E., Dartmouth	Oct.	26,	1865.
Doane, F. W. W., City Engineer, Halifax	Nov.	3,	1886.
Downs, Andrew, M. Z. S. L., Halifax	Feb.	5,	1863.
Egan, T. J., Halifax	Jan.	6,	890.
Forbes, John, Halifax	March	14,	1883.
Foster, Jas. G., Barrister, Dartmouth	March	14,	1883.
Fox, John J., Montreal	May	8,	1882.
Fraser, Principal C. F., School for the Blind, Halifax	March	31,	1890.
Fyshe, Thomas, Halifax	Jan.	9,	1888.
Gilpin, Edwin, M. A., F. G. S., F. R. S. C., Deputy Commissioner of Mines, Halifax	April	11,	1873.
Gilpin, J. Bernard, M. D., M. R. C. S. L., F. R. S. C., Annapolis	Jan.	5,	1863.
Hare, A. A., Bedford	Dec.	12,	1881.
Harris, Herbert, Halifax	Jan.	31,	1880.
Keating, E. H., City Engineer, Duluth	April	12,	1882.
Kennedy, W. T., The Academy, Halifax	Nov.	27,	1869.
Laing, Rev. Robert, Halifax	Jan.	11,	1885.
Lawson, Prof. George, Ph. D., LL. D., F. I. C., F. R. S. C., Dalhousie College, Halifax	March	7,	1864.
Macdonald, Simon D., F. G. S., Halifax	March	14,	1881.

MacGregor, Prof. J. G., M. A., D. Sc., F. R. SS. C. & E., Dalhousie College, Halifax	Jan.	11,	1877.
McInnes, Hector, LL. B., Halifax	Nov.	27,	1889.
McKay, Alexander, Supervisor of Schools, Halifax	Feb.	5,	1872.
MacKay, A. H., B. A., B. Sc., F. S. Sc. L., F. R. S. C., Superintendent of Education, Halifax	Oct.	11,	1885.
Mackay, E., B. A., Principal High School, New Glasgow	Nov.	27,	1889.
McLeod, John, F. S. Sc. L., Demerara	Nov.	1,	1878.
Macnab, William, Halifax	Jan.	31,	1890.
Morrow, Arthur, M. D., Halifax	Nov.	27,	1889.
Murphy, Martin, C. E., D. Sc , Provincial Engineer, Halifax	Jan.	15,	1870.
O'Hearn, P., Principal St. Patrick's Boys' School, Halifax	Jan.	6,	1890.
*Parker, Hon. D. McN., M. D., M. L. C., Halifax			
Pearson, B. F., Barrister, Halifax	March	31,	1890.
Piers, Harry, Halifax	Nov.	2,	1888.
Poole, H. S., A. R. S. M., F. G. S., General Supt. of Pictou Coal Mines, Stellarton	Nov.	11,	1879.
Read, H. H., M. D., Halifax	Nov.	27,	1889.
Robb, D. W., M. E., Amherst	March	4,	1890.
Rogers, W. H., Amherst	March	4,	1890.
Rutherford, John, M. E., Halifax	Jan.	8,	1865.
Shine, Michael, Halifax	Dec.	3,	1891.
Silver, A. P., Halifax	Dec.	12,	1887.
Silver, W. C., Halifax	May	7,	1864.
Smith, Capt. W. H., F. R. G. S., Halifax	Nov.	27,	1889.
Somers, John, M. D., Halifax	Jan.	11,	1875.
Stewart, John, M. B. C. M., Pictou	Jan.	12,	1885.
Uniacke, Robert J., C. E., Halifax	March	9,	1885.
Wilson, R. J., Secretary School Board, Haliiax	May	3,	1889.

ASSOCIATE MEMBERS.

Bishop, W. L., Kentville	Jan.	6,	1890.
Caie, Robt., Yarmouth	Jan.	31,	1890.
Calkin, Principal J. B., M. A., Normal School, Truro	Jan.	6,	1890.
*Cameron, A., Principal of Academy, Yarmouth	Nov.	27,	1889.
Coldwell, Prof. A. E., A. M., Acadia College, Wolfville	Nov.	27,	1889.
Faribault, E. R., C. E., Ottawa	March	6,	1888.
Hardman, J. E., M. E., Oldham, N. S	March,	4,	1890.
Harris, Prof. C., Roy. Mil. Coll., Kingston, Ont.	Nov.	13,	1881.
*Johns, T. W. Yarmouth	Nov	27,	1889.
Kennedy, Prof., King's College, Windsor	Nov.	9,	1882.
McKenzie, W. B., C. E., Moncton, N. B.	March	31,	1882.
Matheson, W. G., M. E., New Glasgow, N. S.	Jan.	31,	1890.
Patterson, Rev. G., D. D., New Glasgow, N. S.	March	12,	1878.

*Life Members.

Pineo, A. J., A. B., Pictou....................................April 4, 1884.
*Reid, A. P., M. D. C. M., L. R. C. S. E., L. C. P. & S. C., Supt. of Hospital for Insane, Halifax ....Jan. 31, 1890.
Smith, Prof. H. W., B. Sc., Trnro............................
Wilson, B. C., Manager Acadia Powder Co., Waverley, N. S...March 4, 1890.

CORRESPONDING MEMBEBS.

Ambrose, Rev. J., D. C. L., Digby ....Jan. 31, 1890.
Bailey, Prof. L. W., Ph. D., F. R. S. C., N. B. University, Fredericton, N. B...Jan. 6, 1890.
Ball, Rev. E. N., Tangier, N. S..............................Nov. 29, 1871.
Bethune, Rev. C. J. S., Port Hope, Ontario ....
Dawson, Sir J. W., C. M. G., LL. D., F. R. S., Principal of McGill University, Mentreal ....Jan. 31, 1890.
Duns, Prof. John, New College, Edinburgh ....Dec. 30, 1887.
Fletcher, Hugh, B. A., Geol. Survey, Ottawa ....Mar. 3, 1891.
Ganong, W. F., B. A., Instructor in Botany, Harvard College, Cambridge, Mass.......................................Jan. 6, 1890.
Harvey, Rev. Moses, LL. D., F. R. S. C., St. John's, N. F.... Jan. 31, 1890.
King, Major, R. A..Nov. 19, 1877.
McClintock, Vice-Admiral Sir Leopold, Kt., F. R. S. ....June 10, 1880.
Marcou, Jules, Cambridge, Mass.............................Oct. 12, 1871.
Matthew, G. F., M. A., F. R. S. C., St. John, N. B............Jan. 6, 1890.
Smith, Hon. Everett, Portland, Me., U. S. A. ....March 31, 1890.
Spencer, Prof. J. W., A. M., Ph. D., F. G. S., State Geologist, Atlanta, Ga., U. S. A. ....Jan. 31, 1890.
Trott, Capt., S. S, *Minia*, Anglo-American Telegraph Co ......Jan. 31, 1890.
Weston, Thos. C., Geological Survey, Ottawa ....May 12, 1877.

* Life Member.

LIST OF INSTITUTIONS TO WHICH COPIES OF VOL. VII, PART 4, OF THE PROCEEDINGS AND TRANSACTIONS HAVE BEEN SENT.

I. AMERICA.

(1.) CANADA.

Antigonish, N. S.—St. Francis Xavier's College.
Belleville, Ont.—Murchison Scientific Society.
Cap Rouge, Qu.—Le Naturaliste Canadien.
Charlottetown, P. E. I.—Prince of Wales College.
" P. E. I. Natural History Society.
Fredericton, N. B.—New Brunswick University.
Guelph. Ont.—Ontario Agricultural College.
Hamilton, Ont.—Association for the promotion of Literature, Science and Art.
Halifax, N. S.—Nova Scotia Historical Society.
" Office of Commissioner of Mines.
" The Legislative Library.
" The Halifax Teachers' Professional Library.
" Dalhousie College.
" The Halifax Academy.
" U. S. Consulate-General.
London, Ont.—Entomological Society of Ontario.
Montreal, Qu.—Natural History Society of Montreal.
" Numismatic and Antiquarian Society.
" McGill College.
" Horticultural Society.
" Microscopical Society.
" Canadian Society of Civil Engineers.
New Glasgow, N. S.—The High School.
Ottawa, Ont.—Royal Society of Canada.
" Geological and Natural History Survey of Canada.
" Field Naturalists' Club.
" Ottawa Literary and Scientific Society.
" Department of Marine and Fisheries.
" Library of Parliament, House of Commons.
" Canadian Mining Review.
" L'Institut Canadien-Francais.
Pictou, N. S.—The Pictou Academy.
Prince Albert, Sask.—The Saskatchewan Institute.
Quebec, Qu.—Geographical Society.
" L'Institut Canadien.
" Literary and Historical Society.
" Laval University.

Sackville, N. B.—Mt. Allison College.
St. John, N. B.—New Brunswick Natural History Society.
St. Thomas, Ont.—Elgin Historical and Scientific Institute.
Toronto, Ont.—The Canadian Institute.
" Director of the Meteorological Service.
" University of Toronto.
" Trinity College.
Truro, N. S.—Normal School.
" Provincial School of Agriculture.
Victoria, B. C.—Natural History Society of British Columbia.
Windsor, N. S.—King's College.
Wolfville, N. S.—Acadia College.
Winnipeg, Man.—Manitoba Historical and Scientific Society.
" Manitoba University.
Yarmouth, N. S.—Milton Library.
" The Academy.

(2.) United States.

Albany, N. Y.—New York State Museum of Natural History.
" Albany Institute.
Ames, Iowa.—State Agricultural College.
Amherst, Mass.—Hatch Experiment Station, Mass. Agricultural College.
Baltimore, Md.—Peabody Institute.
" John Hopkins University.
" Maryland Academy of Sciences.
Beloit, Wis.—Chief Geologist.
Boston, Mass.—American Academy of Arts and Sciences.
" Boston Society of Natural History.
Bridgeport. Conn.—Bridgeport Scientific Society.
Brooklyn, N. Y.—Entomological Society.
Brookville, Ind.—Brookville Society of Natural History.
" Indiana Academy of Science.
Buffalo, N. Y.—Buffalo Society of Natural Sciences.
Cambridge, Mass.—Museum of Comparative Zoology, Harvard College.
" Cambridge Entomological Club.
" Peabody Museum of American Archæology and Ethnology.
Champaign, Ill.—Illinois State Laboratory of Natural History.
Chapel Hill, N. C.—Elisha Mitchell Scientific Society.
Charleston, S. C.—Elliott Society of Science and Art.
Chicago, Ill.—Academy of Sciences.
Cincinnati, Ohio.—Cincinnati Society of Natural History.
" Ohio Mechanics' Institute.
" Historical and Philosophical Society of Ohio.
Colorado Springs, Col.—Colorado College Scientific Society.
Columbus. Ohio.—Geological Survey of Ohio.
" Ohio Institute of Mining Engineers.
Davenport, Iowa.—Davenport Academy of Natural Sciences.

Denver, Col.—Colorado Scientific Society.
Frankfurt, Ky.—Kentucky Geological Survey.
Granville. Ohio.—Denison University.
Houston, Texas.—Texas State Geological and Scientific Association.
Indianapolis, Ind.—The State Geologist of Indiana.
Iowa City, Iowa.—State University of Iowa.
Ithaca., N. Y.—Cornell University.
Jefferson City, Mo.—State Geologist, Geological Survey of Missouri.
Kansas City, Mo.—Kansas City Academy of Sciences.
Knoxville, Tenn.—Tennessee Agricultural Experiment Station.
Lansing, Mich.—Agricultural College.
Lincoln, Neb.—University of Nebraska.
Little Rock, Ark.—Geological Survey of Arkansas.
Madison, Wis.—Academy of Science, Arts and Letters.
Meriden, Conn.—Meriden Scientific Association.
Milwaukee, Wis.—Wisconsin Natural History Society.
" Public Museum of the City of Milwaukee.
Minneapolis, Minn.—Minnesota Academy of Natural Science.
" Geological and Natural History Survey of Minnesota.
Montpelier, Vt.—State Board of Agriculture, Manufactures and Mining.
New Haven, Conn.—Connecticut Academy of Arts and Sciences.
New Orleans, La.—Academy of Natural Sciences.
" Louisiana State University.
Newport, R. I.—Newport Natural History Society.
New York, N. Y.—New York Academy of Sciences.
" American Museum of Natural History, Central Park.
" New York Microscopical Society.
" American Institute of Mining Engineers.
" School of Mines, Columbia College.
" New York Academy of Anthropology.
" Linnean Society of New York.
" Association of Engineering Societies.
" American Society of Mechanical Engineers.
" Torrey Botanical Club.
" American Geological Society.
" American Chemical Society.
" American Geographical Society.
" American Society of Civil Engineers.
Philadelphia, Pa.—Academy of Natural Sciences.
" American Philosophical Society.
" Franklin Institute.
" Wagner Free Institute of Science.
" Pennsylvania University.
" American Entomological Society.
" Zoological Society of Philadelphia.
" Geological Survey of Pennsylvania.
" The Engineers' Club.

Portland, Me.—Society of Natural History.
Poughkeepsie, N. Y.—Vassar Brothers' Institute.
Princeton, N. J. — E. M. Museum of Geology and Archæology, Princeton College.
St. Louis, Mo.—St. Louis Academy of Science.
" The Engineers' Club.
" Missouri Botanical Garden (The Library).
St. Paul, Minn.—St. Paul Academy of Natural Sciences.
Salem, Mass.—Essex Institute.
" American Association for the Advancement of Science.
" Peabody Academy of Sciences.
San Diego, Col.—San Diego Society of Natural History.
San Francisco, Cal.—California Academy of Sciences.
" California State Mining Bureau.
" Technical Society of the Pacific Coast.
Santa Barbara, Cal.—Society of Natural History.
Sedalia, Mo.—Sedalia Natural History Society.
Topeka, Ka.—Kansas Academy of Science.
" Washburn College Laboratory of Natural History.
Trenton, N. J.—Trenton Natural History Society.
Troy, N. Y.—Rensselaer Society of Engineers.
University of Virginia, Va.—Leander McCormick Observatory.
Washington, D. C.—Smithsonian Institution.
" Bureau of Ethnology, Smithsonian Institution.
" U. S. National Museum.
" U. S. Geological Survey (Department of the Interior.)
" U. S. Commissioner of Fish and Fisheries.
" U. S. Commissioner of Agriculture.
" The Chief Signal Officer (War Department.)
" The Chief of Engineers (War Department.)
" U. S. Coast and Geodetic Survey.
" Office of Indian Affairs (Department of the Interior.)
" The Surgeon-General of the U. S. Army.
" The Commissioner of Education.
" Bureau of Navigation.
" Bureau of Steam Engineering (Navy Department.)
" The Director of the Mint (Treasury Department.)
" Hydrographic Office (Navy Department.)
" National Academy of Sciences.
" Philosophical Society.
" Anthropological Society of Washington.
" American Ornithologists' Union.
" Chemical Society.
Wilkesbarre, Pa.—Historical and Geographical Society.
Winchester, Mass.—Commissioner of Inland Fisheries and Game.
Worcester, Mass.—Clark University.

(3.) MEXICO.

Mexico City.—Museo Nacional.
" Sociedad Cientifica "Antonio Alzate."
" Observatorio Meteorologico-magnetico Central.
" Sociedad Mexicana de Historia Natural.

(4.) COSTA RICA.

San Josè.—Museo Nacional.

(5.) CUBA.

Habana.—Sociedad Antropologica de la Isla Cuba.

(6.) HAYTI.

Port-au-Prince...Société des Sciences et de Geographie.

(7.) JAMAICA.

Kingston.—The Institute of Jamaica.

(8.) BRAZIL.

Rio de Janeiro.—Museo Nacional.
" Escola de Minas de Ouro Preto.

(9.) ARGENTINE REPUBLIC.

Buenos Aires.—Museo Nacional.
" Instituto Geografico Argentino.
Cordoba.—Academia Nacional de Ciencias.
La Plata.—Museo de la Plata.

II. EUROPE.

(1.) ENGLAND.

Aberdare, S. Wales.—S. Wales Institute of Engineers.
Barnsley.—Midland Institute of Mining and Mechanical Engineers.
Bath.—Postal Microscopical Society.
Birkenhead.—Literary and Scientific Society.
Birmingham.—Birmingham and Midland Institute.
" Birmingham Philosophical Society.
" Birmingham Natural History and Microscopical Society.
" Institution of Mechanical Engineers.
Bristol.—Bristol Naturalists' Society.
Camborne.—Mining Association and Institute of Cornwall.
Cambridge.—Cambridge Philosophical Society.
" Mineralogical Society of Great Britain and Ireland.
Cardiff.—Cardiff Naturalists' Society.
Carlisle.—Cumberland and Westmoreland Association for the Advancement of Literature and Science.

Dudley.—Dudley Geological and Scientific Society.
Falmouth.—Royal Cornwall Polytechnic Society.
Halifax.—Yorkshire Geological and Polytechnic Society.
Kew, Surrey.—Director of Royal Gardens.
Leeds.—Philosophical and Literary Society.
" Conchological Society.
" Yorkshire Naturalists' Union.
Leicester.—Literary and Philosophical Society.
Liverpool.—Liverpool Polytechnic Society.
" Geological Association.
" Literary and Philosophical Society.
" Naturalists' Field Club.
" Physical Society.
" Biological Society.
London.—Linnean Society.
" Royal Microscopical Society.
" Zoological Society.
" Victoria Institute.
" National Fish Culture Association.
" Geologists' Association.
" Entomological Society.
" Anthropological Institute of Great Britain and Ireland.
" British Museum.
" British Museum (Natural History Department).
" Geological Society of London.
" Essex Field Club.
" Iron and Steel Institute.
" Physical Society.
" Quekett Microscopical Club.
" Royal Colonial Institute.
" Royal Institution of Great Britain.
" Royal Society.
" Society of Arts.
" Society of Antiquaries.
" Mining Journal.
" University College Biological Society.
" Royal Asiatic Society of Great Britain and Ireland.
" Institution of Mechanical Engineers.
" Pharmaceutical Society of Great Britain.
" Society of Chemical Industry.
" Institution of Civil Engineers.
" Chemical Society.
Manchester.—Literary and Philosophical Society.
" Owens College.
" Field Naturalists' Society.
" Geological Society.

Manchester.—Geographical Society.
" Scientific Students' Association.
" Manchester Museum, Owens College.
Newcastle-on-Tyne.—North of England Institute of Mining and Mechanical Engineers.
" Natural History Society of Northumberland, Durham, and Newcastle-upon-Tyne.
" Northeast Coast Institution of Engineers and Shipbuilders.
" Society of Chemical Industry.
Norwich.—Norfolk and Norwich Naturalists' Society.
Penzance.—Royal Geological Society of Cornwall.
Plymouth.—Plymouth Institution and Devon and Cornwall Natural History Society.
Swansea.—Royal Institution.
Taunton.—Somersetshire Archæological and Natural History Society.
Truro.—Royal Institution of Cornwall.
Warwick.—Warwickshire Field Club.
York.—Yorkshire Philosophical Society.

(2.) SCOTLAND.

Aberdeen.—Natural History Society.
Berwick.—Berwickshire Naturalists' Field Club.
Dumfries.—Dumfriesshire and Galloway Natural History and Antiquarian Society.
Dundee.—Dundee Naturalists' Society.
" University College.
Edinburgh.—Edinburgh Geological Society.
" Royal Physical Society.
" Royal Society.
" Royal Observatory.
" Royal Scottish Society of Arts
" Botanical Society.
" Royal Scottish Geographical Society.
" Highland and Agricultural Society of Scotland.
" Scottish Microscopical Society.
Glasgow.—Geological Society of Glasgow.
" Natural History Society.
" Philosophical Society.
" Andersonian Naturalists' Society.
" Scottish Journal of Natural History.
" Institution of Engineers and Shipbuilders of Scotland.
Perth.—Society of Natural History.

(3.) IRELAND.

Belfast.—Naturalists' Field Club.
" Belfast Natural History and Philosophical Society.

Dublin.—Royal Dublin Society.
" Royal Geological Society of Ireland.
" Royal Irish Academy.
" Science and Art Museum.
" University Experimental Science Association.
" Geological Survey of Ireland.
" Institution of Civil Engineers of Ireland.

(4.) France.

Amiens.—Société Linnéenne du Nord de la France.
Angers.—Société Nationale d'Agriculture, Sciences et Arts.
Apt.—Société Litteraire, Scientifique et Artistique.
Arras.—Academie des Sciences, Lettres, et Arts.
Auch.—Société Francaise de Botanique.
Auxerre.—Société des Sciences Historiques et Naturelles de l'Yonne.
Besançon.—Academie des Sciences, Belles Lettres et Arts.
Bordeaux.—Société des Sciences Physiques et Naturelles.
" Société Linnéenne.
" Academie Nationale des Sciences, Belles Lettres et Arts.
" Société de Geographie Commerciale de Bordeaux.
Caen.—Academie des Sciences, Arts et Belles Lettres.
" Société Linnéenne de Normandie.
Cherbourg.—Société Nationale des Sciences Naturelles.
Dijon.—Academie des Sciences, Arts et Belles Lettres.
Gueret.—Société des Sciences Naturelles et Archeologiques de la Creuse.
La Rochelle.—Academie de la Rochelle.
LeHavre.—Société Geologique de Normandie.
Lille.—Société Geologique du Nord.
" Société de Geographie de Lille.
Lyons.—Academie des Sciences, Belles Lettres et Arts.
" Société d'Agriculture, Histoire Naturelle, et Arts Utiles.
" Société Linnéenne.
Marseilles.—Société Scientifique Industrielle.
Montpellier.—Academie des Sciences et Lettres.
Nancy.—Société des Sciences.
Paris.—Academie des Sciences de l'Institut de France.
" Ecole Polytechnique.
" Faculté des Sciences de la Sorbonne.
" Musée d' Histoire Naturelle.
" Société d' Anthropologie de Paris.
" Société de Biologie.
" Société d' Encouragement pour l' Industrie Nationale.
" Société Entomologique de France.
" Société Geologique de France.
" Société Francaise de Mineralogie.

Paris.—Société Francaise de Physique.
" Société Philotechnique.
" Société Zoologique de France.
" Société Mathematique de France.
" Association Francaise pour l' Avancement des Sciences.
" Annales des Mines.
" Feuille des Jeunes Naturalistes.
" Annales des Ponts et Chaussées.
" Société des Ingenieurs Civils.
" Société Chimique de Paris.
" Bulletin des travaux de Chimie executeés daus les laboratoires departementaux.
" Société Malacologique de France.
" Société Botanique.
" Jardin des Plantes.
St. Etienne.—Société de l' Industrie Minerale.
Toulouse.—Academie des Sciences, Inscriptions et Belles Lettres.
" Société d' Histoire Naturelle.
" Société des Sciences Physiques et Naturelles.

(5.) GERMANY.

Augsburg.—Naturhistorischer Verein.
Bamberg.—Naturforschende Gesellschaft.
Berlin.—Gesellschaft für Erdkunde zu Berlin.
" Königlich preussische Akademie der Wissenschaften.
" Physikalische Gesellschaft.
" Deutsche Geologische Gesellschaft.
" Gesellschaft naturforschender Freunde.
" Berliner Gesellschaft für Anthropologie, Ethnographie und Urgeschichte.
" Deutsche Chemische Gesellschaft.
" Botanischer Verein der Provinz Brandenburg.
" Deutscher Entomologischer Verein.
" Deutscher Fischerei Verein.
Bonn.—Naturhistorischer Verein der preuss. Rheinlande, Westfalens u. d. Reg.-Bezirks Osnabrück.
Braunschweig.—Verein für Naturwissenschaft zu Braunschweig.
Bremen.—Naturwissenschaftlicher Verein.
Brünn.—Naturforschender Verein.
Calsruhe.—Naturwissenschaftlicher Verein zu Carlsruhe.
Cassel.—Verein für Naturkunde.
Chemnitz.—Naturwissenschaftliche Gesellschaft.
Danzig.—Naturforschende Gesellschaft.
Darmstadt.—Verein für Erdkunde.
Dresden.—Königliches Mineralogisches Museum.
" Gesellschaft für Natur-und Heilkunde.
" Naturwissenschaftlicher Verein "Isis."

Dresden.—Zoologisches und Anthropologisches Museum.
" Verein für Erdkunde zu Dresden.
Elberfeld.—Naturwissenschaftlicher Verein.
Emden.—Naturforschende Gesellschaft.
Erfurt.—K. Akademie Gemeinnützigier Wissenschaften.
Erlangen.—Die Universität.
" Physikalisch-medizinische Societät.
Frankfurt, a. M.—Senckenbergische Naturforschende Gesellschaft.
" Deutsche Malakozoologische Gesellschaft.
Frankfurt, a. O.—Naturwissenschaftlicher Verein.
Freiberg (Saxony).—Naturforschende Gesellschaft.
Freiburg (Baden).—Naturforschende Gesellschaft.
Gera.—Gesellschaft von Freunden der Naturwissenschaften.
Giessen.—Grossherzogliche Universität.
" Oberhessische Gesellschaft für Natur-und Heilkunde.
Görlitz.—Oberlausitzsche Gesellschaft der Wissenschaften.
" Naturforschende Gesellschaft.
Göttingen.—Königliche Gesellschaft der Wissenschaften.
Güstrow.—Verein der Freunde der Naturgeschichte in Mecklenburg.
Halle, a. S.—Kaiserlich deutsche Akademie der Naturforscher.
" Naturwissenschaftlicher Verein für Sachsen und Thüringen.
" Naturforschende Gesellschaft.
Hamburg.—Zoologische Gesellschaft.
" Naturhistorisches Museum.
" Verein für Naturwissenschaftliche Unterhaltung.
" Naturwissenschaftlicher Verein.
Hannover.—Naturhistorische Gesellschaft.
Heidelberg.—Naturhistorisch-medizinischer Verein.
Jena.—Medizinisch-naturwissenschaftliche Gesellschaft.
Kiel.—Die Universität.
" Naturwissenschaftlicher Verein für Schleswig-Holstein.
Königsberg.—Königliche physikalisch-ökonomische Gesellschaft.
Landshüt.—Botanischer Verein.
Leipzig.—Verein für Erdkunde zu Leipzig.
" Königlich sächsische Gesellschaft der Wissenchaften.
" Naturforschende Gesellschaft.
Lüneburg.—Naturwissenschaftlicher Verein.
Madgeburg.—Naturwissenschaftlicher Verein.
Mannheim.—Verein für Naturkunde.
Marburg.—Gesellschaft zur Beförderung der gesammten Naturwissenschaften.
Metz.—Verein für Erdkunde.
Mulhouse (Alsace).—Société Industrielle de Mulhouse.
München.—Königlich baierische Akademie der Wissenschaften.
" Deutsche Gesellschaft für Anthropologie, Ethnologie und Urgeschichte.
" Geographische Gesellschaft.

Münster.—Westfalischer Provinzialverein für Wissenschaft und Kunst.
Nürnberg.—Naturhistorische Gesellschaft zu Nürnberg.
Offenbach, a. M.—Verein für Naturkunde.
Regensburg.—K. B. Botanische Gesellschaft.
" Naturwissenschaftlicher Verein.
Strassburg.—Die Universität.
Stuttgart.—Verein für vaterländische Naturkunde in Württemberg.
Tübingen.—Botanisches Institut.
Wiesbaden.—Nassauischer Verein für Naturkunde.
Würzburg.—Physikalisch-medizinische Gesellschaft.
" Unter-fränk. Kreisfischereiverein.
" Die Universität.

(6.) AUSTRIA-HUNGARY.

Agram.—Société Archeologique.
Buda-Pesth.—K. Ungarische Naturwissenschaftliche Gesellschaft.
" Ungarisches National Museum.
Graz.—Zoologisches Institut.
" Naturwissenschaftlicher Verein für Steiermark.
Kolosvar.—Société du Musée de Transylvanie.
Prag.—Königlich böhmische Gesellchaft der Wissenchaften.
" Naturhistorischer Verein "Lotos."
" Böhmische Chemische Gesellschaft.
Schemnitz.—K. Ungarische Akademie.
Trieste.—Societá Adriatica di Scienze Naturali.
" Museo Civico di Storia Naturali di Trieste.
Vienna.—Anthropologische Gesellschaft.
" Kaiserliche Akademie der Wissenschaften.
" K. K. geologische Reichsanstalt.
" K. K. naturhistorisches Hofmuseum
" K. K. Zoologisch-botanische Gesellschaft.
" Internationales Permanentes Ornithologisches Comité.
" Wissenschaftlicher Club in Wien.
" Oesterreichischer Ingenieur und Architekten Verein.
" Zoologisches Institut.
" Verein zur Verbreitung Wissenschaftlicher Kenntnisse.

(7.) ITALY.

Acireale (Sicily.)—Societá Italiana dei Microscopisti.
Bologna.—Accademia delle Scienze dell' Istituto di Bologna.
Florence.—Istituto di Studi Superiori.
" Soeietá Entomologica Italiana.
" Societá Italiana di Antropologia, Etnologia e Psichologia comparata.
" Societá Botanica Italiana.
Genoa.—Museo Civico di Storia Naturali.
" Societá di Letura e Conversazione Scientifiche.

Milan.—Reale Istituto Lombardo di Scienze, Lettere et Arti.
" Societá Italiana di Scienze Naturali.
" Societá di Industriali Italiana.
" R. Istituto Technico Superiore.
Modena.—Academie Royale des Sciences, Lettres et Arts.
Naples.—Societá Reale di Napoli (Accademia delle Scienze Fisichc e Mathematiche.)
" Stazione Zoologica.
" Societá dei Naturalisti in Napoli.
Palermo.—Circolo Matematico di Palermo.
" Accademia Palermitana di Scienze, Lettere ed Arti.
" Hortus Botanicus Palermitanus.
" Société des Sciences Naturelles.
Pisa.—Societá Toscana di Scienze Naturali.
" Societá Malacologica Italiana.
Rome.—Accademia Pontificia de Nuovi Lincei.
" R. Accademia dei Lincei.
" R. Comitato Geologico Italiano.
" Bullettino di Bibliografia e di Storia delle Scienze Mathematiche e Fisiche.
" Societá Italiana delle Scienze.
" Societá Geologica Italiana.
" Direzione del Giornale del Genio Civile.
" Rassegna delle Scienze Geologiche in Italia.
Siena.—R. Accademia de Fisiocritici in Siena.
Turin.—Reale Accademia delle Scienze.
" Musei di Zoologia ed Anatomia comparata, Universita di Torino.
Venice.—Reale Istituto Veneto di Scienze, Lettere ed Arti.

(8.) Switzerland.

Basel.—Naturforschende Gesellschaft.
Bern.—Commission Geologique Federale.
" Schweizerische Naturforschende Gesellschaft.
" Société Geologique Suisse.
Chur.—Naturforschende Gesellschaft Graubündens.
Frauenfeld.—Naturforschende Gesellschaft.
Geneva.—Institut National Genevois.
" Société de Physique et d'Histoire Naturelle.
" Société des Arts.
" Société de Geographie de Genève.
Lausanne.—Société Vaudoise des Sciences Naturelles.
Neuchatel.—Société des Sciences Naturelles.
St. Gallen.—St. Gallische Naturwissenschaftliche Gesellschaft.
Zürich.—Naturforschende Gesellschaft.

(9.) Belgium.

Brussels.—Société Royale de Malacologique de Belgique.
" Academie Royale des Sciences des Lettres et des Beaux Arts.

Brussels.—Musée Royal d'Histoire Naturelle de Belgique.
" Société Royale de Botanique de Belgique.
" Société Scientifique de Bruxelles.
" Société Entomologique de Belgique.
" Société Belge de Microscopie.
" Société Belge de Geologie, de Paleontologie et d'Hydrologie.
Liége.—Société Geologique de Belgique.
" Société Royale des Sciences de Liége.
" Société des Sciences.
Luxembourg.—Institut Royal Grand-ducal de Luxembourg.
Mons.—Société des Arts et des Lettres du Hainaut.

(10.) NETHERLANDS.

Amsterdam.—Koninklijke Akademie van Wetenschappen.
" Koninklijke Zoologisch Genootschap.
Harlem.—Bibliothéque du Musée Teyler.
" Société Hollandaise des Sciences.
Helder.—Nederlandsche Dierkundige Vereenigung.
Leyden.—The University.
Rotterdam.—Société Batave de Philosophie Experimentale.
Utrecht.—Provinciaal Utrechtsch Genootschap van Kunsten en Wetenschappen.

(11.) DENMARK.

Copenhagen.—Société Royale des Antiquaires du Nord.
" Kongelige Danske Videnskabernes Selskab.
" Kongelige Universitetet.
" Botaniske Forening.
" Naturhistoriske Forening.

(12.) NORWAY.

Bergen.—Museum.
" Selskabet for de Norske Fiskeriers Fremme.
Christiania.—Det Meteorologiske Institut.
" Kongelige Norske Fredericks Universitet.
" Videnskabs Selskabet i Christiania.
" Norges Geografiske Selskab.
" Polytekniske Forening.
" Norges Geografiske Opmaaling.
" Norwegische Commission der Europaeischen Gradmessung.
Stavanger.—Museum.
Throndjem.—Videnskabernes Selskab.
Tromsö.—Museum.

(13.) SWEDEN.

Lund.—Kongliga Universitetet.
" Kongliga Fysiografiska Sällskapet.
Stockholm.—Kongliga Svenska Vetenskaps Akademien.

Stockholm.—Svenska Sällskapet för Antropologi och Geografi.
" Geologiska Förening i Stockholm.
" Acta Mathematica.
" Entomologisk Förening.
Upsala.—Kongliga Universitetet.
" Société Royale des Sciences.

(14.) Russia.

Helsingfors (Finland).—Société des Sciences de Finlande.
" Societas pro Fauna et Flora Fennica.
Kharkow.—Société des Naturalistes de l'Université Imperial.
" Société des Sciences Experimentales.
Kiew.—Société des Naturalistes de Kiew.
Moscow.—Société Imperiale des Naturalistes.
" Société Imperiale des Amis des Sciences Naturelles d'Anthropologie et d'Ethnographie.
Odessa.—Société des Naturalistes de la nouvelle Russie.
St. Petersburg.- Comité Geologique de la Russie (Institut des Mines).
" Jardin Imperial de Botanique.
" Academie Imperial des Sciences.
" Société Physico-chimique Russe a l'Université.
" Societas Entomologica Rossica.
" Société des Naturalistes.

(15.) Portugal.

Lisbon.—Academie Royale des Sciences de Lisbonne.

(16.) Spain.

Madrid.—Commission Geologica de Espana.
" Real Academia de Ciencias exactas fisicas y naturales.

III. ASIA.

(1.) India.

Bombay.—Anthropological Society.
" Bombay Branch Royal Asiatic Society.
" Natural History Society.
Calcutta.—Survey of India Department.
" Geological Survey of India.
" Indian Museum.
" Asiatic Society of Bengal.

(2.) China.

Shanghai.—China Branch Royal Asiatic Society.

(3.) Japan.

Tokio.—Imperial University.
" Asiatic Society of Japan.

IV. AFRICA.

(1.) Cape Colony.

Cape Town.—South African Philosophical Society.
" South African Museum.

(2.) Mauritius.

Port Louis.—Royal Society of Arts and Sciences.

V. AUSTRALASIA.

(1.) Australia.

Adelaide, South Australia.—Royal Society of South Australia.
" The Government Geologist.
" Philosophical Society.
" Public Library, Museum and Art Gallery.
" The Government Botanist.
Brisbane, Queensland.—Acclimatization Society of Queensland.
" Royal Society of Queensland.
Melbourne, Victoria.—National Museum.
" Field Naturalists' Club of Victoria.
" Mining Department.
" Royal Society of Victoria.
" Victoria Institute of Surveyors.
" Geological Society of Australasia.
" Government Botanist.
Sydney, New South Wales.—Australian Museum.
" Mining Department.
" Royal Society of New South Wales.
" Technological Museum.
" Engineering Association of N. S. Wales.
" Linnean Society of N. S. Wales.

(2.) New Zealand.

Auckland.—Auckland Institute.
Christchurch.—Philosophical Institute of Canterbury.
Dunedin.—Otago Institute.

Wellington.—Colonial Museum.
" New Zealand Institute.

(8.) Tasmania.

Hobart Town.—Royal Society of Tasmania.

TRANSACTIONS

OF THE

Nova Scotian Institute of Science.

SESSION OF 1890-91.

I.—Notes on the Surface Geology of South-Western Nova Scotia.—By Prof. L. W. Bailey, M. A., Ph. D.

(Received Oct. 22nd, 1890.)

In all regions the features which distinguish their surface geology necessarily have an interest from the intimate connection which they hold with their topography, drainage, agricultural and commercial capacity, as well as from the fact that they mark the last phases or series of events by which these features have attained their present form. In the Province of Nova Scotia all these relations find ample illustration, and are well deserving of careful study; but here, as will presently appear, the subject has an added interest from the relation which these geological features bear, in some instances at least, to the distribution and development of our mineral wealth.

Having, during the past summer, in connection with the work of the Dominion Geological Survey, had an opportunity of making a somewhat careful examination of certain portions of the Province, and more particularly the counties of Queen's and Shelburne, the author proposes to state here a few of the results of his observations, as bearing upon the topics referred to. He would be glad to know that they are in accordance with those of other observers in portions of the Province with which he is not familiar.

In looking, for the first time, at a map of South-Western Nova Scotia, there are two features in its topography which at once attract attention, viz., (1) the broken and indented character of the coast, and (2) the abundance of inland lakes. A closer examination of these features, in connection with the character of the surface, will reveal, in important particulars, a community of origin.

(1.) The extent to which the coast is marked by a broken and indented shore line will perhaps be better appreciated when it is stated that, taking only the two counties to which these remarks more particularly relate, the distance in a straight line, from the eastern boundary of Queens to the western boundary of Shelburne, parallel to the general trend of the coast, is only about sixty-five miles, while if the bays and indentations be followed, even if all minor regularities be omitted, this distance is more than two hundred and forty miles. If with this we take into account the innumerable islands, large and small, with which the coast abounds, the bearing of this feature upon the commercial relations, the fishing industries and the navigation of the latter, as well as upon the habits and character of its people, will be at once apparent.

The majority of the indentations referred to are at right angles to the coast line and therefore approximately north and south. Taking only the most important harbors, those of Port Medway, Liverpool Bay, Port Mouton, Port Joli, Port L'Herbert, Sable River, Jordan Bay, Shelburne Harbor, Negro Harbor, Port La Tour and Barrington Bay, it will be found that the majority have a trend which varies but little from N. and S. (magnetic), the length of the indentations varying from two or three to ten miles and their width from one to two miles. A similar conformity to a general north and south trend is equally evident in the long narrow promontories by which these inlets are separated, as it not unfrequently is also in the position and form of the associated islands.

Such uniformity of arrangement, as also of contour, in each case quite different from that which the underlying rock formations would be calculated to produce, is explicable only upon one

supposition, viz., that of ice excavation. The indentations referred to are veritable fiords, and even were there no other evidence than that of position, form and depth, they would at once be recognized as marking a former period of excessive glaciation. Additional evidence, if needed, is, however, everywhere to be found in grooved and polished rock surfaces, in innumerable boulders of every size and shape, together with the arrangement of the latter in some instances in parallel bands or trains, corresponding in direction to that of the bays and headlands.

The material of the larger boulders varies to some extent with that of the nearest exposed rock-ledges, and in most instances they would seem not to have been transported to any great distance from their parent-beds. Granite boulders, usually well rounded and sometimes of large size, are however often met with widely removed from any known outcrops of similar rock. Some considerable islands seem to be almost entirely made up of granite boulders, while in the vicinity of granite outcrops, as in Port Mouton and about Barrington Passage, they are so thickly strewed, and are often of such huge dimensions, as greatly to increase the dangers of navigation. Much of the granite quarried at Shelburne is from huge boulders, some of them thirty or forty feet in diameter.

(2.) If now we pass from the coast to the interior, the evidences of glacial action as having been chiefly concerned in the determination of the surface features are equally evident. Within the area of the two counties under discussion, no prominent hill range is to be found, but the great central granite axis of Nova Scotia is but little removed from their northern boundaries, sending a spur into north-eastern Queens, and traversing the western part of Shelburne quite to the coast. South of this axis the surface is that of a moderately elevated plateau, diversified by innumerable low hills, none of which probably exceed an elevation of 400 feet. Many of these hills are of a rounded hummocky character, but many also are in the form of long narrow ridges. It is remarkable that these latter have very generally an approximately north or south course, irrespective of the underly-

ing rocks, and that their steeper sides are turned to the west. They are wholly composed of drift, in some instances made up to a large extent of boulders, and presenting the aspect of lateral moraines; in others, largely composed of gravel and sand, forming veritable kames or horsebacks. Apart from these ridges, which rise somewhat prominently above the general level of the country, and which are often of very considerable length, there are also some remarkable contrasts in the ordinary depth and distribution of the drift covering. Over certain belts, having an east and west course, the boulders, often of enormous size, are so thickly and so widely scattered that little else is seen; in other and parallel belts, on the other hand, the underlying rocks are barely covered with soil or are wholly denuded. The former feature is most common in connection with the so-called "whin" belts, and is well exhibited about Ponhook and Molega Lakes; the latter when the underlying rocks are slates. It is however over the slate belts that the best soils and farming lands are to be found, the whin and granite country being for the most part indescribably barren.

The character and distribution of the drift, partly in north and south hills and partly in east and west belts, some of which may have been terminal or frontal moraines, have been the chief determining causes in the formation of the remarkable system of lakes to which reference has already been made. Within the two counties under consideration the number of these lakes is certainly not less than one hundred, besides innumerable lakelets and ponds. Though not confined to any particular region they are most abundant, as well as of the largest size, in connection with the belts of whin and granite, Lake Ponhook, Molega Lake, the Christopher Lakes and Lake Rossignol being all situated in the former, while Pleasant Lake, Tupper Lake and others, either border or are included within areas of the latter. They are often also in groups or belts, as well illustrated in the Christopher Lakes, occupying east and west depressions. In most cases the lakes contain numerous islands which are often only piles of boulders, and scattered blocks, often of huge dimensions, help to make their navigation somewhat difficult and danger-

ous. In several instances the contents of these lakes were distinctly seen to be held up by drift dams across their natural outlets, and their whole grouping and configuration is strongly suggestive of a region resulting from a long continued and intensely powerful glacial erosion, followed by a slow melting of the ice cap and the very imperfect removal of the resulting waters. In some instances, as along Tupper Lake, where the rocks are partly granite and partly whin, the effects of striation, polishing, distribution of erratics and the formation of *roches moutonnees*, are very remarkable, and could hardly be better illustrated in the Alpine valleys of Switzerland.

From a comparison of numerous observations upon the glacial striae in the interior of Queens County, (chiefly north of Ponhook and Molega Lakes) these were found to vary from S. 10 E. to S. 20 E., being in a few instances S. 30-35 E., and in one case having an easting of as much as 60°. In two instances striae having a course S. and S. 10 E. were accompanied by other and apparently later striae showing a course S. 30 W. On the coast of this county the striae are more nearly north and south, being frequently S. or S. 5 E., rarely S. 18-20 E. Going westward into Shelburne the striae along the coast become more variable, those between Jordan Ferry and Negro Harbor often exhibiting a westerly tendency (S. 10 W.), while between Port LaTour and Baccaro they again become a little easterly. In the interior of Shelburne, between Clyde and Ohio, a course of S. 70 W. was observed at one point.

It has been stated in the introductory remarks that apart from the relations which the features above described must obviously have to the agricultural and industrial aspects of the regions in which they occur, they have also an interest in being directly connected with the distribution and development of mineral wealth. There are three ways in which the importance of a knowledge of the superficial deposits will be readily seen, viz.: (1), as tending to hide from view metalliferous lodes beneath a covering of drift, as well as tending to obscure the study of the associated rock structures; (2), as helping to guide the miner or prospector in his search for productive lodes; (3), as bearing

upon the possible existence of "placer" deposits or alluvial diggings along the course of old channels of drainage. A few words may be added upon each of these points.

(1). Over very considerable areas the covering of drift is such as to completely conceal from view the underlying strata. As already remarked, this is particularly true of the whin belts along or in the vicinity of which the principal auriferous lodes occur. This covering is often composed largely of boulders which may be piled up in great heaps and often attain immense proportions, but when these are less frequent, (for they are seldom wholly absent), there are commonly thick beds of coarse gravel or, in the numerous depressions, extensive peat bogs and barrens. The thickness of the superficial deposits is, in the absence of kames, ordinarily about seven or eight feet, but may be twenty feet or more, while the height of local drift ridges or kames may be as much as one hundred feet.

(2). While these superficial deposits thus hide from view the underlying rocks, and thus greatly enhance the difficulties of the explorer and prospector, they may, nevertheless, be so employed by him as to lead the way to the discovery of lodes of which otherwise he might never suspect the existence. I have been informed that in the case of several of the most important mines at Molega and Whiteburne, the first discoveries of gold were made in quartz-bearing boulders, which were then carefully traced back to their parent source. From the nature and origin of the drift these are naturally sought to the north of the localities in which the boulders occur, and the distance travelled has apparently usually been but slight, commonly not over half a mile. In trenching or costeening the surface, the quartz boulders are found to increase in number as well as in size as the lode is approached, and when this is passed, to suddenly cease. They are also said to be invariably sharp and angular, not rounded, and to be more deeply buried near the lode than at points more remote from the latter. Intelligent and practical prospectors even maintain that they can recognize from hand specimens of gold quartz the lead from which they were derived.

(3.) The larger parts of the superficial deposits of South-

Western Nova Scotia being clearly attributable to the agency of moving ice, and the search for auriferous deposits having been shown to be ultimately connected with the direction and amount of boulder transport by this agency, one is naturally led to enquire what relations, if any, may be traced between such transfer and the position of existing valley depressions, as also whether or not any evidences can be obtained of former river channels, post-glacial or pre-glacial, different from those which now mark the surface. Regarding the former poiut it may be remarked that in the case of both Queens and Shelburne, the more considable rivers, such as the Port Medway, Liverpool, Broad, Sable Jordan and Roseway, reach salt water at the head of corresponding indentations of the coast, and for long distances inland have very nearly the same course as the latter—a course (S. 10-20 E.) which corresponds also with the average direction of the drift. It is noticeable also that these streams, though large and rapid, occupy, as a rule, valleys of inconsiderable depth, the bed of the stream being often but a few feet below the level of the surrounding country. It may perhaps be inferred from these facts that the existing drainage is comparatively recent, and the circumstance already referred to that many of the lakes upon which these streams are so largely dependant are drift-dammed lakes, helps to give probability to this conclusion. If such is the case it may be presumed that most of the existing streams, originating in the melting ice of the glacial era, were directed in their flow by the local circumstances of the time, and to a large extent irrespective of previously existing channels, many of which may have been at the same time obliterated. As to whether or not any old and now abandoned channels of drainage exist or are to be recognized, almost nothing of a reliable nature is known. As, however, has been pointed out by Dr. Selwyn and others, the subject is a very important one, for in all gold regions such ancient river beds are found to be rich repositories of gold, and there is no reason to suppose that in this respect Nova Scotia is any exception. To determine this point very careful and minute studies both of the character and distribution of the superficial deposits of the Province are required, but these have not as yet been made.

In the present article the author has merely brought together a few facts, the results of observations incidental to other work. It may be hoped that the more systematic survey referred to may ere long be undertaken, and that it may be amply justified by its results.

II.—Steam Boiler Tests as a means of Determining the Calorific Value of Fuels.—By D. W. Robb.

(Received Dec. 6th, 1890.)

It will be recognized by those who use large quantities of fuel, especially of bituminous coals, that they differ very greatly in value, even coals which are taken from adjoining areas give very different results, so that it is sometimes puzzling to the consumer and difficult to decide upon the merits and proportionate values of the various fuels within his reach. It is likewise difficult to determine when the greatest practicable amount of work is being obtained from the fuel, and consumers are frequently subjected to great loss from the want of this knowledge. There are three recognized methods of determining the calorific value of coal, viz: by chemical analysis, by the use of a calorimeter, and by actual measurement of the water evaporated by a definite amount of fuel in a steam generator.

By the first method it is possible to ascertain the constituents of the fuel in their various proportions and to determine the theoretical heat value when combined with a definite proportion of pure oxygen, and approximately to compute the amount of heat which would be converted into work when combined with ordinary air, and consumed under usual conditions. But this becomes a complicated problem, as will be seen when it is considered that the heat absorbed and wasted in heating the non-combustible constituents of both the air and fuel must be taken into account and that these wastes vary with the amount of superfluous air admitted through the grate, and with the proportion of noncombustible matter in the fuel; therefore, any estimate of the practical value of a fuel deduced from chemical analysis can only be approximate.

In testing fuels by a calorimeter a sample of the fuel mixed with chlorate of potassium is placed in an open-mouthed copper vessel, which is submerged open mouth downward, like a diving bell, in a vessel containing a measured quantity of water, com-

bustion of the fuel takes place and the heat produced is absorbed by the water—the total quantity of heat being determined by the rise in temperature of the water. This method has some advantages over an analysis, and, if care is exercised in the selection of samples to be tested—or a large number of samples tested—is perhaps the best means of establishing a theoretical standard calorific value of a fuel; but the quantity tested is necessarily small, and may not fairly represent the fuel. It also leaves out the heat absorbed by the non-combustible portions of the air and fuel, which is an important factor in the combustion of fuel under ordinary conditions.

The method, by which the fuel is consumed under actual conditions and in large quantities, in evaporating water in a steam boiler is generally regarded as a test of the efficiciency of the generator, rather than as a test of the value of the fuel; but somewhat extended observations of the performance of various steam generators, using similar grades of coal, has convinced the writer that the steam boiler test, when properly conducted, is quite as valuable as a means of determining the calorific value of fuel, and of comparing various fuels, as for finding the efficiency of the generator—in fact, the latter is the more uncertain of the two, because, unless a boiler is tested with fuel of a known calorific value, it is impossible to arrive at its actual efficiency, or to compare it fairly with any other form of generator.

In testing the heat of fuel in an ordinary steam boiler, two elements of uncertainty are introduced, viz, loss through imperfect combustion of the fuel, and the escape of gases at a higher temperature than the atmosphere; but as these losses, as well as the heat absorbed by the non-combustible portions of the air and fuel, are unavoidable in the present state of science, they should be taken into account in making a practical test of fuel, and strict accurancy only requires that the loss be uniform and minimum in result. Practical experience teaches that almost perfect combustion may be attained in any of the common forms of steam generator by careful and regular stoking, with a properly regulated air supply; and, that this skill is possessed by many ordinary stokers, who have no knowledge of the laws which

govern the combustion of fuels, will doubtless be admitted by many persons who have observed locomotive firemen or others who are compelled to get a high rate of steam production. It is, of course, impossible to transfer all the heat produced in combustion to the water in a generator, because the gases cannot be reduced below the temperature of the water or steam within the generator, and a certain temperature above the atmosphere is necessary to produce draught in the chimney; but it is quite possible to so proportion the grate surface to the heating surface of the boiler that the gases will be reduced to a certain minimum temperature and maintained at that temperature during a test. The temperature may be indicated by a pyrometer or high registering thermometer at the base of the chimney, and the rate of flow of the gases may be ascertained by the use of a draught-gauge. Frequently an attempt is made to analyse the waste gases. This gives an uncertain result on account of the difficulty of getting representative samples of the gases; but, from observation and examination of many tests, the writer believes it unimportant, if the stoking and air regulation receive proper attention. The surface of the grate should be so proportioned to the heating, or heat absorbing, surface of the generator that the gases will, when they reach the uptake, be reduced to, say, 400 Far. Skilful firing and air regulation will produce practically perfect combustion and uniform temperature.

Steam boiler tests, although attended with some difficulty, are quite within the reach of ordinary consumers, and deserve to be better understood and used more than they are. In addition to their value as a method of determining the heating properties of fuel, they furnish the best possible means of ascertaining the condition and efficiency of the generator and of checking, and if necessary correcting, waste on the part of the stoker. It is desirable that such tests should be made frequently, because steam boilers are very liable to deteriorate and become wasteful, especially when set in brick, through the cracking of the brick walls, as well as by the coating of heating surfaces with scale or other deposit on the inner, and soot or ashes on the outer, surfaces. It is quite practicable for steam users to have tests made

by their engineers and ordinary assistants, but it is preferable to have an occasional test made by a professional engineer who has had experience in making such tests, as he will have gained special knowledge which will enable him to detect and locate imperfections in the generator more readily than those unaccustomed to such work.

The writer would suggest to steam users the following practice: that one or more tests be made by an expert to determine the efficiency of the generator, and that he may direct any necessary repairs or corrections in the generator. After this has been done and a standard of efficiency established a good water meter should be inserted in the water supply pipe, so that a record of the water used may be continuously kept and the stoker or engineer should keep a log and make daily reports of the coal consumed and water evaporated. The meter readings will need correction if absolute accuracy is desired, but for practicable purposes this may not be necessary. It may seem like unnecessary labor and expense to weigh all the coal used, but a short trial will undoubtedly prove its value, as it will not only indicate constantly the condition of the generator, but to a certain extent be a check upon the working of the engine and the amount of power used by the establishment, and it will furnish a constant incentive to the engineer, stoker, and those in charge of the steam machinery, to improve its working and reduce the rate of fuel consumption to its lowest limits. A general practice of this kind throughout the country would induce a rivalry in the saving of fuel, parallel to that found in marine practice, where it is claimed a horse power is produced by from one and a half to two pounds of fuel per hour, instead of four to ten pounds, the last named quantity being not uncommon in ordinary steam plant, and would in the course of a few years cause an enormous saving to the country as well as to individual consumers.

Rules governing the standard system of boiler trial, adopted by the American Society of Mechanical Engineers, may be found in the transactions of that Society, Vol. VI, 1884. The following simple instructions will enable any steam user to conduct

a test of his boilers for the purpose of comparing the values of fuels, etc., after the efficiency of the generator has been established by a complete test by an expert, (observations of the quality of steam, strength of chimney draught and analysis of gases are omitted as they require special instruments and skilled manipulation.)

INSTRUCTIONS FOR CONSUMERS TEST.

A test to be of any value should be continued for not less than ten hours, and will require the constant attention of not less than four persons besides the regular attendants, appointed as follows: one or two men to weigh the coal, and one or two to attend to and weigh the water, one clerk to keep the log of the coal and water weighed, and one clerk to record the pressure of steam, temperature of feed water, temperature of chimney gases, and to keep a gross account of the coal and water as a check to the regular log. These should be careful men, well posted as to their duties. Three good platform scales will be required and two tanks, or clean tight casks, to weigh water in. Preparation should be made so that the water can all be delivered into two tanks, which are placed upon two platform scales, and the water pumped alternately from the tanks to the boiler, a piece of hose attached to the suction pipe of the pump or injector will be convenient to transfer from one tank to the other. It will be advisable to procure from reliable instrument makers, one or two accurate thermometers for the purpose of taking the temperature of the feed-water and chimney gases. The temperature of the feed-water should be taken by inserting a brass or copper cup in the feed pipe near its connection with the boiler; this cup may be filled with oil and the thermometer set in the oil. The temperature of the cold water before it enters the injector or feed water heater should also be taken. Great care should be exercised that all scales, steam gauges, etc., are correct, and that there are no leaks about the pumps, pipes or boiler, by which any water may escape without being evaporated; steam leaks are not material except as misrepresenting to consumption of the engine. The

temperature of escaping gases may be taken by inserting a brass or copper pipe with closed end in the smoke connection where it leaves the boiler; this cup, which should reach the centre of the escaping gases, may be filled with oil and a high registering thermometer placed in it.

Previous to the hour for starting, say at 6.30 o'clock, steam should be up to the working pressure, and the tubes and all surfaces and flues should be swept clean. The ash pit should be cleaned and the first charge of kindling and coal, or the fuel to be used, should be weighed; every man should be at his post; those who are to note the various readings provided with ruled forms for recording the gross, tare, and net weights of fuel and water, and others for the pressure of steam temperatures of feed-water and escaping gases, which should be noted every quarter hour. At the hour for starting, the height of water in the boiler should be marked on the gauge glass, so that it may be brought to the same place at the close of the test, and the fire should be drawn quickly and replaced with the weighed kindlings and fuel, (wood kindlings are generally taken at 4-10 the value of coal by weight.) The working of the boiler may be conducted as usual in every way, the stoking should be done carefully, so that no waste may occur through dead spots or holes in the fire, or uneven distribution of fuel. If the fire be too thick, some of the gas will pass off unconsumed for want of sufficient air, and if the fire be too thin, too much air will be admitted. The draught or air supply should be regulated by the ash pit doors or registers, and an even fire and steady pressure of steam maintained throughout the test. If work is to be suspended at mid-day, or any time during the test, the drafts may be closed, the fire banked, and an attendant left in charge who will regulate the fire if necessary, so as to keep the pressure constant. At the close of the test the water should be brought to the same level in the boiler as at the beginning, and the fire withdrawn and deadened quickly with water. The remaining coal should be weighed and deducted from the quantity charged to the boiler, and the ashes may also be weighed. The net weights of coal and water may

then be summed up and the result of the test ascertained and recorded in the following manner:

Test of boiler at day of 18
Kind of Boiler
Dimensions
No. tubes
Size of fire-box
Grate surface sq ft.
Heating surface "
Height of chimney
Size "
Duration of test hours.
Kind of fuel
Boiler pressure (by gauge) lbs.
Temperature of feed-water entering boiler deg. Far.
" " " pump or injector "
" escaping gases "
Total fuel consumed .... lbs.
Percentage of moisture in fuel............ per cent.
Equivalent dry fuel..................... lbs.
Total weight of ash..................... "
Equivalent combustible.................. "
Total water evaporated.................. "
Water evaporated per hour .... "
" " per pound of dry fuel.... lbs.
" " " " " from and at 212° "
" " " " combustible " " " "
Horse power developed..................

The above particulars are determined in the following manner: The pressure of steam and temperatures of feed-water, and gases are taken from the average readings of the same.

The total quantities of fuel, ash and water, are taken from the net summing of log, great care being taken that no error is made. The percentage of moisture in fuel is determined by drying a sample of the fuel for 24 hours and getting the difference between the wet and dry weights, which difference is multiplied by 100 and divided by the weight of sample before drying.

The equivalent dry fuel is found by multiplying the total quantity of fuel by the percentage of moisture and dividing by 100, which is deducted from the total quantity of fuel. The equivalent combustible is found by deducting the total amount of ash from the total quantity of fuel.

The water evaporated per hour is the total quantity of water divided by the number of hours duration of test.

The water evaporated per pound of dry fuel is the total quantity of water divided by the total quantity of dry fuel.

The water evaporated per pound of fuel from and at 212° is found by multiplying the water evaporated per pound of fuel by the total heat, or heat units, of one pound of steam at the average pressure, less the total heat of one pound of feed-water before entering the boiler or injector, if one be used, and dividing the product by 966 which is the total heat, in units, of one pound of steam at 212°.

The horse power is determined by deducting the total heat units of one lb. of feed water at the average temperature before entering boiler or injector, if one be used, from the total heat units of one pound of steam at the average pressure, and multiplying the product by the quantity of water evaporated per hour and dividing by 1110, (which are the heat units required to raise one pound of water from 100° and evaporate it at 70 lbs. pressure), the quotient should be divided by 30, which will give the horse power according to the American standard. The following is an example of this method of finding the horse power.

Total quantity of water evaporated = 2000 lbs.
Steam pressure (by guage), 60 lbs.
Temperature of feed water before entering boiler or injector, 40°.
Total heat of 1 lb. of steam at 60 lbs. pressure = 1175 B. T. U.
" 1 " feed water, at 40° = 8 B. T. U.

1175.7—8. × 2000 ÷ 1110.3 = 210.33 ÷ 30 = 70 H. P.

Example of finding the equivalent evaporation from and at 212°.
Water evaporated per lb. of fuel, 10 lbs.
Average pressure by gauge, 60 "
" temperature of feed water, 40°.

Total heat of 1 lb. steam of at 60 lbs. pressure, 1175.710 heat units.

Total heat of 1 lb. of feed water at 40°. 8. heat units.

EXAMPLE:

10. × 1175.710—8. ÷ 966 = 12.08 lbs.

In comparing fuels, as with the efficiency of the boilers, the quantity of water evaporated per pound of fuel, from and at 212° should always be used. The actual quantity of water evaporated per pound of fuel will differ with variations of temperature of the feed-water entering the boiler, and also with the steam pressure or temperature at which the steam leaves the boiler, but the quantity evaporated per pound of fuel from and at 212° allows for these variations and gives a true comparison of the value of fuel if the efficiency of the generator is constant, or of the efficiency of the generator if the calorific value of the fuel is known. The temperature of saturated or dry steam always corresponds with the pressure, but if from any cause the steam be not dry, it will carry away less heat in proportion to weight, or, if the steam be superheated by contact of the products of combustion with the steam surface of the boiler, it will carry away more heat. In either case the result of the test will be vitiated, unless the quality of the steam be ascertained and accounted for. This is usually done by means of a calorimeter, one of the best of which, known as the "Barrus Calorimeter," was designed by Mr. Geo. H. Barrus, of Boston. No attempt has been made to ascertain or account for the quality of steam in the simple test given because it would complicate the work, and it is intended that a professional test of the boiler should include this important item, and, if the boiler is found abnormal in this respect, the expert should either give directions for the removal of the cause, or provide a formula for the correction of the error due to wet or superheated steam in future tests.

The following table will be found useful in ascertaining the equivalent rates of evaporation horse-power, etc.

STEAM TABLE.

Pressure of steam by guage	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120	125
Temperature.........	286.9	292.5	297.8	302.7	307.4	311.8	316.	320.	323.9	327.6	331.1	334.5	337.8	341.	344.1	347.1	350.	352.8
Total heat of evaporation above 32° in heat units,	1169.4	1171.2	1172.7	1174.3	1175.7	1177.0	1178.8	1179.5	1180.7	1181.8	1182.9	1183.9	1184.9	1185.9	1186.8	1187.8	1188.6	1189.5

FEED WATER.

Temperature of feed-water	32	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
Total heat above 32° in heat units	0	8.06	18.1	28.1	38.1	48.1	58	68	78	88.1	98.1	108.2	118.3	128.4	138.8	148.5	158.6	168.7

III.—Analyses of Nova Scotia Coals and other Minerals. —By E. Gilpin, Jr., A.M., F.G.S., Inspector of Mines, Etc.

(Read March 9th, 1891.)

The following analyses, for the most part hitherto unpublished, may be interesting for comparison. They have been made by the writer, and may be considered as representing fair averages.

The value of proximate analyses for commercial purposes has certain limits. By its means, in a properly averaged sample representing a bed of coal, the amount of moisture, of ash, and of sulphur, can be determined. The estimations of the amounts of volatile matter, and of fixed carbon, vary with the time of heating, amount of heat, bulk of sample, etc., so that they can be regarded only as approximate. For the same reasons, the gas values of coals are not satisfactorily determined in the laboratory by this method of analysis. The quality of the coke as left in the crucible after determination of volatile combustible matter, is not always found to correspond with that obtained in practice.

The time and cost of ultimate analyses of coal have prevented their adoption for general commercial purposes, and their value may be based principally upon the view, that as they give the total percentage of carbon present in the coals, they are in accord with the idea that the ultimate evaporative power of a coal is in direct proportion to the amount of carbon it contains. The determinations of sulphur and ash by proximate analysis are equally valuable for ordinary purposes.

It is remarkable that more attention is not paid by purchasers to the composition and comparative values of the fuels offered to them. The slight differences in prices which are sometimes allowed for coals generally acknowledged to be of lower grade are in many cases disproportionate to the differences really existing. To manufacturers, and other large consumers, the study of this matter would prove a considerable item of profit in balancing cost sheets.

In every metallurgical business ores are bought by the percentage of metal they contain, limits are fixed for the impurities, and within these limits the amount to be deducted from the value of the metal varies.

Thus, two coals, showing respectively—

Combustible matter	92.00	92.00
Water	.50	2.50
Sulphur	.50	.50
Ash	7.00	5.00

will not have the same values as fuels, nor equal adaptability for many metallurgical purposes. Now, assuming the amount of combustible matter to be suited to the purposes of the purchaser, and he wishes to make gas for lighting, the first fuel is worth more to him than the second; while to the purchaser for domestic purposes, the lessened amount of ash in the second coal would outweigh the amount of moisture he would have to purchase with it.

1. Coal from the Victoria Colliery of the Low Point, Barasois, and Lingan Mining Company.

Coal bright and compact, breaking into elongated blocks, and blocks having a cubical fracture. The deposition planes are well marked, and carry a good deal of mineral charcoal, and some of the primary planes have films of calcspar. Pyrites is sometimes visible in the deposition planes, and occasionally is presented in small nodules. The average specific gravity of the coal is about 1.3.

Composition:

	Slow Coking.	Fast Coking.
Moisture	.75	.75
Volat. Comb. matter	26.85	32.13
Fixed carbon	68.13	62.85
Ash	4.27	4.27
	100.00	100.00
Sulphur	1.286	
Theoretical evaporative power	9.3	8.6

From the above figures the coal is evidently of excellent quality, and should be found a good steam coal. Its percentage of volatile matter and moisture are lower than is usual in coals from this district, and approach those characterising the typical steam coals of the United States. The coal yielded during analysis a bright and fairly compact coke, and in practice would probably yield a merchantable article of good quality.

2. Coal from the Sydney main seam of the General Mining Association (Sydney Mines.)

This seam is considered the equivalent of the Victoria seam, referred to in Analysis No. 1. The actual connection has not yet been proved, although the levels of the Sydney Mines are being rapidly extended toward it under the harbor.

The coal is bright, and fairly compact, breaking irregularly. It shows little visible pyrites and spar. By fast and by slow coking the following results were obtained:—

	Slow Coking.	Fast Coking.
Moisture	·420	·420
Volatile combustible matter	34·962	37·110
Fixed carbon	59·993	57·845
Ash	4·625	4·625
	100·000	100·000
Sulphur	.95	.95

As compared with the analysis from the Victoria seam coal, it is decidedly more bituminous, and contains less sulphur. From its behaviour under analysis it should in practice yield a good volume of illuminating gas, of a fair candle power. The coals are alike in their moisture and ash contents. The coal yielded a bright and coherent coke. In practice, small amounts of coke are burned at this mine in beehive ovens, and the article produced is of good quality, which would be improved if its manufacture were carried on continuously.

I put here, side by side, two analyses of the ash of these coals,

one made by me some years ago, the other made by the late Dr. How:—

	Victoria.	Sydney.
Iron peroxide	56.543	51.33
Alumina	6.456	4.84
Insoluble residue	27.500	29.50
Manganese	1.930	....
Magnesia	.035	.23
Lime	2.598	3.05
Lime Sulphate	....	10.98
Sulphuric Acid	3.790	....
Phosphoric Acid	.690	Trace.
Alkalies	.150	Trace.
Chlorine	....	Trace.
	99.693	100.00

3. Coal from Mabou, Inverness County.

This coal was regarded as an Anthracite. I am not aware of the age of the rocks it occurs in. Color black, and lustrous. Breaks with uneven fracture into irregular shaped pieces. In the fire kindles slowly, and burns without flame, yielding a fair heat. The ashes left is white, and retains the shape of the original piece as put on the fire.

On analysis, it yielded:

Volatile matter	2.73
Fixed Carbon	43.71
Ash	53.56
Sulphur	Trace.
	100.00

From its composition and its behaviour in the fire, it may be classified as a highly carbonaceous shale.

A similar mineral found at Lepreaux, near St. John, New Brunswick, was analysed by me some years ago, and proved to contain an amount of ash nearly equal to that of the Mabou sample. As the percentage of ash in an ordinary commercial

Anthracite of fair quality should not exceed 10 per centum, it will be seen that these deposits are far below the standard.

Cumberland County Coals.

The following analyses are of samples of coal from seams opened out recently by Mr. E. Sharp, and others, of Amherst, at Stanley, a short distance east of the Styles' mine. The samples were all from the crop, and more or less covered with clay.

4. Sample No. 1, marked from "North" Seam. Hard and compact, breaking with a cubical fracture; color black, with a bright lustre; no visible pyrites, and no mineral charcoal on deposition planes. Its composition was:

Moisture	2.35
Volatile combustible matter	35.86
Fixed carbon	53.36
Ash	8.43
	100.00
Sulphur	.52

Coke moderately compact by fast coking. Sample kindled readily, and burned with a long white flame, and gave a moderate amount of smoke.

5. Sample No. 2. Marked "Bottle-Glass" Seam.

Coal fairly compact, hard, and breaking with a conchoidal fracture; color black and lustrous, with a few thin, dull layers; streak black. A few visible crystals of pyrites and a little mineral charcoal. The partings held a few films of rusted calcic carbonate. Composition:

Moisture	3.82
Volatile combustible matter	30.15
Fixed carbon	56.13
Ash	9.90
	100.00
Sulphur	.75

Coke slightly coherent by fast coking; sample ignited readily and burned with a moderate amount of smoke.

6. Sample No. 3. Marked "Canneloid Coal from upper part of Eight-feet Seam."

Coal hard and compact, with cubical fracture; color dull black, with brownish-black streak. Burned with clear white flame, and left an ash equal in bulk to the original fuel.

It yielded:

Volatile matter	36.50
Ash	63.50
	100.00

This composition represents a moderate amount of volatile combustible matter.

7. Sample No. 4, marked "Bench of Eight Feet Seam."

Coal fairly bright and compact, fracture uneven; a little mineral charcoal and a little visible pyrites.

Composition:

Moisture	4.10
Volatile combustible matter	29.85
Fixed carbon	59.13
Ash	6.92
	100.00
Sulphur	1.25

Coal burned readily with good flame.

8. Joggins Main Seam.

Coal bright and lustrous, breaking with little dust and a cubical fracture. The planes hold a few films of calcspar and pyrites. A sample representing both benches yielded:

	Slow Coking.	Fast Coking.
Moisture	1.115	1.115
Volatile combustible matter	32.582	34.050
Fixed carbon	60.013	58.565
Ash	6.290	6.290
	100.000	100.000
Sulphur	1.25	1.25

Some years ago, in a paper read before the Montreal meeting of the British Association for the advancement of Science, I gave the average composition of the coals of the Cumberland coal field as folllows:

Moisture	1.46
Volatile combustible matter	33.69
Fixed carbon	59.35
Ash	5.50
	100.00

From this it will be seen that the seams of coal represented by the analyses given in this paper compare favorably with the average.

9. Magnetic Iron Ore, from Kemptville.

Metallic iron	58.20
Silicious matter	11.50
Sulphur and Phosphorus	Traces.

The ore is said to occur in a vein three feet wide.

10. Sample of Red Hematite from Greener Mine, George's River, Cape Breton County.

Vein said to be from six to nine feet wide, and is situated on high ground, near deep water on the Bras D'or Lake. As will be seen from this analysis, the ore is of excellent quality. The rock in which it is found is, I believe, of Lower Silurian age. The slates, etc., composing this horizon are in this locality very full of finely disseminated peroxide of iron.

Moisture	1.10
Iron oxide	89.30
Silicious and clayey matter	7.82
Lime	.67
Magnesia	.88
Phosphoric Acid	.20
Sulphur	Trace.
	99.97

Metallic Iron	62.50
Phosphorus	.09
Sulphur	Trace.

11. Manganese Ores, Walton.

Soft Black Ore.

Manganese (available oxide)	90.15
Iron Oxide	2.55
Barytes	1.12
Moisture	2.05
Silica	2.80
Phosphoric Acid	1.02
Lime Carbonate	Tr.
	99.69

Hard Brown Ore.

Manganese Oxides	85.54
Iron Oxide	1.18
Barytes	.89
Silica	3.27
Phosphoric Acid	.34
Moisture	8.54
	99.76

12. Sample of Limestone, Pictou County.

Carbonate of Lime	85.25
Silcious matter	7.00
Water	.95
Sulphur	Trace.
Phosphorus	"
Iron, Manganese, Magnesia, Alumina	6.80
	100.00

The limestone may be considered as of fair quality, and adapted for use in the process of iron smelting.

IV.—Remarks upon the Coating of Iron with Magnetic Oxide, and a Suggestion of a probably New Method of producing it—By John Forbes.

(Read February 9th, 1891.)

In the production of articles of metal, it is frequently desirable that the condition or color of the surface be changed, sometimes as a matter of taste, the natural color of the metal not comporting with its associations, or with its purposed use; sometimes as a protection of the article from deterioration by natural oxidation, and, in some cases, with both of these aims in view.

Often the surfaces of such articles are intentionally oxidized, and a more uniform and more durable, as well as a more beautiful, oxidation, produced by the artificial means, than that which would result if Nature were left to do the work herself in the ordinary course of wear or of exposure.

Silver articles are frequently artificially coated with a film of sulphuret of silver, which, while being of a more even character both in constitution and color, is also more tasteful and probably more durable than a natural result would produce.

Tin and zinc articles frequently have their surfaces treated in such a manner as to produce a crystalline effect, which is preserved by a thin covering of lacquer, giving a better and more durable effect than if left to the natural action of the atmosphere or other causes.

Copper, after being polished, is made darker, and the natural metallic lustre and redness changed to a dark chocolate color, the surface being thus improved and made more durable.

Iron is frequently covered with tin or zinc, by being dipped (after proper preparation of its surface) into a melted bath of one of those metals.

Steel and iron articles are also frequently treated in such a manner as to produce upon them a thin scale or film of magnetic oxide, Fe_3O_4, which, being a different degree of oxidation than

would naturally occur, and not much (if at all) acted upon by a damp atmosphere, makes a fairly durable finish for such articles, and resists natural changes in a generally satisfactory manner.

Sometimes the artizan, wishing to produce this kind of surface in an expeditious manner, upon an article of steel or iron, will heat the article to a proper degree, and then smear upon it some heavy oil or fat, after which he will continue the heating for a while longer, and thus in a sort of impromptu manner obtain a surface which will resist natural oxidation from exposure to the weather, for a moderate length of time, fairly well. The exact effect of this rough-and-ready process is, probably, that a very thin film of superoxidation by heat is obtained, and, in addition to that, a slight carbonization of the surface, by the burning thereon of the greasy matter with which it had been smeared, and also a filling up of the minute surface-cells of the metal, by the same agent, which becomes hardened by the heat into a more or less durable varnish.

Contrasts in color between different parts of instruments or machines, of iron and steel, and giving very tasteful effects, are produced by simply carrying the oxidation and resulting discoloration to different degrees in the several parts treated. The ranges of color obtainable by proper manipulation and treatment being all the way between that of the brilliancy of the natural and polished surface, through the several tints of pale straw, light, dark, and reddish brown, and purple, to blue, of a very beautiful and agreeable tint, and this without sacrificing much of the brilliancy of the originally finished or polished surface.

The extremely thin films of oxidation thus produced do not, however, possess much durability, and a moderate amount of rubbing, or wear, suffices to remove it, and exposes anew the natural color and surface of the metal.

But if, instead of stopping the operation at this stage just named, we continue the treatment, increasing the heat, with a free access of a suitable oxidizing agent, a considerable coating of the superoxidation may be obtained, and the utility of the treatment as a means of protecting the article from natural deterioration greatly improved.

The treatment thus extended results in a much darker color, approaching very nearly to a black, and where it is intended to produce this kind of a finish, the surface need not be carefully polished beforehand, a smooth and even surface, (with, however, a full exposure of the clear metal), being all that is needed, as the surface after treatment presents a fine granular character, quite pleasing to the eye, but without polish, even though it may have been polished previous to treatment.

It is, however, necessary in order to obtain good results, that the suface be made clean, so that free action of the oxidizing agent may not be interfered with.

The extent of the treatment, and consequent depth of the scale formed, must of course be modified to suit the purposes for which the articles treated are intended to be used.

This kind of coating, as a preventive from further oxidation, has engaged the attention of scientific men, and several methods have been proposed for producing it.

About fourteen years ago, Prof. Barff, of some part of England, devised a method of submitting the articles to be treated to the action of steam, the articles having been raised to a suitable degree of heat in a muffle, the steam was then admitted, and becoming decomposed, the oxygen combined with the iron, and the hydrogen was enabled to escape by a suitable exit pipe.

At first this method was not quite successful, because although the desired oxidation was obtained, yet it was not satisfactory because it did not stick to the iron, but was formed in minute scales that were easily detached. This was afterwards remedied by using superheated steam and quite satisfactory results were then obtained, and the articles so treated present a very nice appearance. The method, however, requires a properly erected apparatus, at a considerable outlay, for its accomplishment. A short time after Prof. Barff's method was introduced, another method of accomplishing the result was invented by a Mr. Bower, of England. Mr. Bower's method consisted in subjecting the suitably heated articles, they being also enclosed, to the action of hot air—the supply of air being renewed from time to time as it became deoxidized, and fresh supplies introduced into the cham-

ber until the desired depth of coating was obtained. This method also requires considerable preparation in the way of suitably arranged facilities for its execution.

I now beg to explain a method which I have had occasion to use, which I have not found suggested by any authority with which I am acquainted, and which may have a field of adaptability in cases where an expeditious or rough and ready way of producing such a coating upon iron and steel articles is desirable. The method consists in enclosing the articles in a sheet iron box, imbedding them in some suitable supporting material which will not absorb oxygen, say blacksmith's scale, or gravel, or sand, and mixing with the contents of the box some substance which will give off oxygen when heated.

After some consideration I conjectured that Black Oxide of Manganese, MnO_2 would be a suitable agent, and upon experimenting was pleased to find my anticipation correct, and after a few trials succeeded in obtaining results which for the desired purpose seemed fairly satisfactory. We found that the thickness of the coating may be increased to an appreciable degree; the colour is quite good and uniform, and the adherent qualities generally satisfactory.

We discovered that the quality of the peroxide of manganese was important, and suffered disappointment in endeavoring to use some that was not adapted to the purpose. It should be of a good, deep black color, aad decidedly granular. That which disappolnted us was of a somewhat brown tinge, and dusty.

It may be interesting to state, that after finding our plan to succeed, we thought we would try the mixing of some other agent with the MnO_2, and so mixed a little chlorate of potash with the oxide of manganese. The result was quite unsatisfactory,—in some cases sticking to the surface, and in others causing the resulting oxidation to be non-adherent, and dropping off in large plates as soon as handled. It is probable that the process as we have hitherto practised it may be improved, as we have only made use of the same appliances, furnaces, etc., that we have used for other purposes in connection with our business. It is, however, in this ready-to-hand feature that the chief utility of the method probably consists.

V.—The Magdalene Islands—By the Rev. George Patterson, D. D., F. R. S. C.

(Read January 19th, 1891.)

The Magdalene Islands are situated nearly in the centre of the Gulf of St. Lawrence. They stretch irregularly in a northeast and southwest direction between lat. 47° 12′ and 47° 51′ N., and between long. 61° 11′ and 62°15′ W., thus extending a distance of about 57 miles at their greatest length, and about 14 at their greatest breadth. The most southern point lies about 50 miles from the east point of P. E. Island, about 60 from Cape North in Cape Breton, and 150 from Gaspe, while the most northeastwardly is only 70 miles from Cape Anguille in Newfoundland, and 85 from the east cape of Anticosti. They thus lie in the very track of the commerce of the gulf and river St. Lawrence.

It will thus be seen that they are in the same latitude as the southern parts of Newfoundland, the northern counties of New Brunswick, or those counties of the Province of Quebec below the city. But their climate is cooler in summer, and milder and more variable in winter, than that of the two last, and on the other hand, more severe in winter, and drier and milder in summer, than that of the first. It is comparatively free from the fogs so prevalent on our Atlantic coast. My experience of the summer is that the climate at that season is delightful, the fiercest heat of a July sun being tempered by an air from the surrounding waters. A medical gentleman whom I met on the islands, who had spent part of two summers there, spoke in the highest terms of their summer climate, and recommended them as just the place for those who wished to rest and recuperate. In winter the thermometer does not fall as low as in the Province of Quebec, but from the dampness, the cold will be felt as keenly. Then all the harbors and bays are frozen over, and the islanders with their hardy ponies can easily pass from one island to another, the whole length of the group (except it may be to

the outlying islets), while from the shore the ice extends for miles, sometimes in level fields, at other times piled in irregular masses. This presents one of the principal inconveniences of the inhabitants. For nearly five months of the year they are shut out from all intercourse with the world except by telegraph.

On approaching the islands from any direction the first appearance they present is that of a range of rounded hills. As we draw nearer the outline becomes more distinct. They are generally hummocky in shape, sometimes forming sharp cones, at others being rounded or flattened on top, or somewhat of a beehive shape. Approaching still closer, we see steep cliffs of red, grey, or brown freestone, and pleased with their variety of hue and shape, we may be impressed almost to awe by their grandeur as we realize their height of one, two, three, or in one instance, four hundred feet, while at their feet the waves beat with ceaseless roar and untiring energy. Then, first as a dim haze on the horizon, but afterward more distinctly, the voyager may trace some sand beach (one is twenty-two miles long), with its dunes of blown sand, forty, sixty, and sometimes, I thought, a hundred feet high. Finally, as one draws near the land, there are seen on the slopes of the hills, toward the shore, clusters of small white cottages, with other buildings, forming the centre of a fishing industry. These buildings are not placed so close together as to form a village, as that term is understood among us, but they are nearer than is usual in our farming settlements.

Wherever a voyager lands, his attention will be arrested by the various appliances for conducting the fishery — stages for drying fish, and a vat for trying out seal blubber, perhaps nets spread out to dry, lobster traps, with many sights, and, we must add, smells, which we must pass over for the present.

But leave the shore, and almost anywhere the beauty of the scenery will arrest attention. If the day is fine, ascend to higher ground, and at almost any point you can scarcely fail to behold a scene, in the contemplation of which, if you are a lover of nature, you will for the time fairly revel, and of which you will carry away delighted remembrances. Before you, and from some positions on either side, stretches the mighty ocean, its surface

unbroken, except by some passing sail, looking in the distance "like wing of wild bird," as we saw it, calm and resplendent under a July sun, even then, however, giving you the idea of a quiet consciousness of reserved power—but soon it may be roused by the tempest to display its awful majesty and irresistible might. In the nearer view the land stretches out in cliffs of varied hue, which are said to resemble those of the Channel Islands, or in long ranges of sand dunes, while often the tints on sea and sky are so beautiful, that travellers have pronounced them such as they have only seen among the islands of the Egean or in the fairest spots of the sunny south. Below you lies some cove or bay, on whose surface may be seen small vessels and boats, in which the hardy fishermen pursue their avocations; around you are many sunny slopes or verdant valleys, thickly dotted with the homes of the inhabitants, suggestive of all the scenes of rural life, while in the rear the view is bounded by a higher range of hills of a rich dark green from the stunted spruce and fir, which are now almost the only trees upon the islands. And all so quiet, perhaps no sound being heard, unless you are near enough to catch the low melancholy murmur of the waves in their ceaseless beat upon the shore. Such is the scene which in the long summer day may be seen at any point in the Magdalene Islands, as is so often seen in God's works, the same in general features, endlessly diversified in details.

If, however, you are of a more practical turn and have come with the idea commonly entertained regarding these islands, you will be delighted and surprised to find them possessing a soil unsurpassed in fertility in these Eastern Provinces. It is a deep, sandy loam, free from stones, easily worked, and under any proper system of agriculture it would yield abundantly all the cereals, grasses and vegetables of the temperate zone.

But any observer of the works of God in nature cannot pass among these islands, without being struck by the exhibition here seen of the working of those agencies, by which the land is covered by the sea, and again the sea turned into dry land. Westward the rocks are a dark red sandstone, as I judge the continuation of the new red sandstone of P. E. Island. These

are very soft. So easily are they disintegrated by the influence of air and water that I have scraped two inches in thickness off the seaward side of them. The sea is thus rapidly wearing them away, but not them only. On the western side of Grindstone Island they are succeeded by harder rocks of the carboniferous formation, which extend eastward and northward the whole length of the group. These, which are mostly sandstones, varying in hue from a light grey to a dark umbery brown, present little more resistance to the power of the disintegrating agencies at work. One cannot walk along the shore without seeing how the cliffs are falling down, and how the fragments are being rolled and rubbed together and ground by the waves. On the land one observes how it has become necessary that the road along the bank should be removed farther inland, or how fields are being gradually diminished. Of the same process a sadder evidence is to be found in the reefs and shoals, which extend from the shore in various directions, once the foundation of the land, but now having the soil and so much of the rock removed by the power of the waves that they form shallows dangerous to navigation. On the other hand from material thus removed fiom the shore or brought down by the rain, bogs and saline marshes are being formed, and lagoons and bays filled up, slowly if we reckon by human life, rapidly if we reckon by geological eras. Men not very old will show where they saw brigs built and loaded, where now you could easily wade across. And your own eye can see how the sea is forming and broadening beaches of gravel or sand, or the wind blowing it into hills. As you walk along these beaches you see how soil is being gradually formed upon them, and how they are becoming occupied by various kinds of vegetation.

In this way in the inner reaches among the islands are formed along their shores extensive tracts of marsh and swamp, intersected by lagoons or shallow lakes, the larger of which it is said once admitted vessels by channels which have since closed up.

Much of these marshes could, with a little effort, be converted into valuable meadow. They, as well as the sand beaches, are covered with coarse grass which the inhabitants cut for feeding

their cattle, or on which they pasture them in summer. Other portions at present cannot be reclaimed or rendered tillable, but yield large quantities of berries, particularly cranberries, which are quite an article of export.

From the situation of these islands, as described, it will be seen that they are right in the track of the trade of the Gulf and the River St. Lawrence, and from their structure as now indicated, but in addition from currents unexpectedly encountered, and of which the causes are scarcely understood, they have been noted as the scene of shipwrecks. Even vessels going by the Straits of Belle Isle have been driven upon them, while those on board imagined themselves at quite a safe distance. If Sable Island has been known as the Graveyard of the Atlantic, with equal, if not greater propriety, may the Magdalenes be called the Graveyard of the St. Lawrence. Not only have such sad events been more numerous; they have, as a general rule, been more destructive of human life. On Sable Island, as I am informed by one who resided on it for seven years, vessels when they strike usually become embedded in the sand, and generally do not break up for two or three days, so that if those on board would remain they might escape, when by attempting to leave they are lost. But at the Magdalenes, vessels may strike upon the rocks and rapidly go to pieces, or may strike on a reef at some distance from the shore, and after being battered upon it, be carried over it to be engulfed in deep water, while in either cases, a few fragments driven to land may be all that remains to tell the tale. Often have vessels left Quebec in the fall and some wreckage found on these shores give the only hint ever received of their fate.

They also often prove fatal to the small vessels of the inhabitants or that are engaged in fishing or trading among them. In rough weather the sea rises very quickly and the waves are very dangerous, not because they are so high, but because they are short and steep. As they approach the shore in huge combers, owing to the shallowness of the water and the undertow, they break on the reefs which in so many places encircle it, or beat upon the sand dunes or cliffs with irresistible force.

Then, there is no good harbor in the whole group, and vessels dodge round for shelter under the land. But a sudden change of wind may convert a safe lee into the means of their destruction. Thus, in the great gale of August, 1873, a number of American fishing vessels had taken refuge in Pleasant Bay, when the wind veered round to the eastward, and in an hour thirty-three of them were ashore, it might be said on top of one another, and all were totally wrecked.

Of such events one sees memorials wherever he goes among these islands. Walk along the beaches, and you will see here pieces of ship plank or timber, or it may be part of a gallant mast, there the remains of some old hull, or again, what seems more wierd and ghastly, a row of the ends of ship timbers, like ribs of a skeleton, projecting above the sand, which has closed round the lower parts of the hull; or, enter the dwellings of the inhabitants, and perhaps you will find pieces of furniture which had belonged to a ship's cabin, or articles that on enquiry you will be told came from some wreck; and in the construction of their buildings you may see old ship's timbers or deals of their cargo. More touching is it still to see the monuments erected by friends in far away lands to mark the resting place of loved ones who had been cast lifeless upon these shores, or the untended graves of the unknown strangers, each somebody's son, and leaving we know not what friends to mourn the loss of those whose fate they will never learn in this world.

Provision is made against the occurrence of such disasters, by lighthouses at the most prominent points, and by a telegraph line the whole length of the islands. But still shipwrecks are occurring. The autumn after my visit an Italian barque went ashore in Pleasant Bay, when those on board supposed they were twenty miles distant from the islands; and the summer following, a vessel from Rio Janeiro, bound for Bay Chaleur, struck on Bryon island and became a total wreck. It must be observed, however, that there is no lifeboat system here, such as is established on the exposed places of the coasts of Britain and the United States. Whether such, if introduced here, could be

made available to avert such disasters, I cannot undertake to determine.

These islands were first discovered by Jacque Cartier on his first voyage in 1534. On the 24th June, leaving a cape in Newfoundland, which he had named Cape St. John, but now known as Cape Anguille, he sailed north-westwardly, and the next day came to two small islands, from the description the Bird Rocks of to-day. Five leagues farther to the west he found another island five leagues in length, by half as much in breadth, which he named Bryon Island, a name which it still retains, though sometimes written Byron Island. He continued his course south-westwardly among the islands, and was much pleased with their fertility. He describes them as full of beautiful trees, woods, pleasant meadows covered with spring flowers, and having large fertile tracts of lands interspersed with great swamps. This description would almost seem to indicate that there had been already cultivation. He says that along the shores were many sea monsters, with two large tusks in the mouth, like elephants. This would seem to show that up to this time he was unacquainted with the walrus.

No mention is made of inhabitants, and none of the Indian tribes seemed to have permanently occupied them, though the Micmacs had a name for them, showing their acquaintance with them, and that they probably sometimes visited them in summer. Probably, however, even before this, and certainly from that time forward, they were visited by the hardy Breton and Basque fishermen in the prosecution of their industry. But we find no particular mention of them in the narratives of the time, and there seems to have been no attempt at settlement upon them till the year 1663, when the company of New France granted the islands to Sieur Francois Doublet, a ship captain of Honfleur. In the following years he associated with him. for the purpose of carrying on a fishing and trading speculation, Francois Gon de Quimee and Claude de Landemare, to whom he transferred one-fourth of his rights. But still there does not seem to have been any attempt at settlement. Fishermen came from France in spring, and after spending the summer in the prosecution of their

industry, returned home with the produce of their labor. And the islands seem to have reverted to the French government, for Charlevoix states that in 1719 the king, at the instance of the Duchess of Orleans, ceded them to the Compte de St. Pierre.

The first settlement is said to have been made in the year 1757 by four families named Boudreault, Chaisson, LaPierre and Cormier, who came from St. Peter's Bay in Prince Edward Island.

In the year 1763 the islands passed with the rest of New France under the British government. At that time they were said to have had but ten families resident upon them, who were engaged in walrus and seal hunting, and to a small extent in the herring and cod fishery. About this time Mr. Gridley, described in one place as an English retired officer, in another as an American skipper, formed an establishment at Amherst Island for the purposes of trading, and especially of carrying on upon a large scale the hunting of the walrus and the seal. He encouraged others of the Acadians to remove hither, so that the population received a number of accessions from this source, and their descendants now form the large majority of the inhabitants, and retain the language, habits and religion of the parent country. But it may be observed that, though they have always been under the government of the Province of Canada or Quebec, their associations are all with their brethren in the maritime provinces.

At this time the hunting of the walrus was considered as second in importance only to that of the whale. The oil brought a good price, the skin was valued as forming an exceedingly tough leather, and the tusks were of the very best ivory. McGregor in his history of British America says: "These animals are fond of being in herds, and their affection for each other is very apparent. The form of the body and of the head, with the exception of the nose being broader, and having two tusks from fifteen inches to two feet long in the lower jaw, is not very unlike that of a seal. A full grown walrus will weigh at least 4,000 pounds. The skins are valuable, being about an inch in thickness, astonishingly tough, and the Acadian French used to cut

them into strips for traces and other purposes. The flesh is tough, hard and greasy, and not much relished even by the Eskimos. They will attack a small boat merely through wantonness; and as they generally attempt to stave it are extremely dangerous. Their blazing eyes and their tusks give them a formidable appearance, but unless wounded or one of their number be killed, they do not seem ever to intend hurting the men. About forty years ago,* a crew of Acadian Frenchmen, in a schooner from Prince Edward Island, caught and killed a young walrus in the Gulf of St. Lawrence. A little time after, as one of the men was skinning it in the boat along side the vessel, an old walrus rose, and got hold of the man between the tusks and forefins, or flippers, and plunged down under water with him, and afterward showed itself three or four times with the unfortunate man in the same position before it disappeared altogether."

Mr. McGregor says that the last incident was well known, and was several times related to him by a brother of the unfortunate man, who was on board the schooner at the time. I had more than once read the story, and when I mentioned it at my boarding-house on the Magdalene Islands, mine host at once replied, "O yes, it's quite true; the man was my grandfather's brother. He had killed the calf, and she singled him out from the rest of the crew."

There was thus some danger in pursuing them in the open sea. But they were in the habit of coming in herds upon the beach or of passing over into the shallow lagoons inside. Their order of march was in single file, and they were said at times to enter some distance into the woods. Even yet a place is known as the Sea-cow's (*vache de marine*) Path. The first effort of the hunters was to get them on shore, and then to urge them forward till they got them a sufficient distance from the water. It is said that for this purpose they would get behind them on a dark night and give the hindmost a prod with a sharp pole. This urged him forward, but, it is said, led him to give his immediate predecessor a similar stimulus, who passed the compliment to the

* Written about 1834.

next, till it reached the end of the line. Away from the water they were comparatively helpless, and fell an easy prey.

From the number of tusks that have been found, I am inclined to believe that for some time they were not valued as an article of trade. Some time ago a trader on the islands offered to purchase from the people all that they could bring to him. The result was that he collected quantities, it is said some tons, which he exported. They are still occasionally found, as the beaches are moved by sea and storm, and are used by the inhabitants as marlingspikes, or cut up for various purposes about their houses or their vessels.

During the American revolutionary war, the property of Mr. Gridley and his associates was destroyed by American privateers. From the slaughter of the walrus it was almost driven from the vicinity, though a few continued to be taken till sometime in the present century. The seals, too, did not come in such large numbers, nor were they so easily captured, though the taking of them has continued to be one of the resources of the people to the present day. These pursuits having decreased in importance, the people were led to give more attention to the taking of cod and herring, which then came in enormous quantities, and also to attend to the cultivation of the soil, which, as I have said, is of excellent quality.

In the year 1798 the whole islands, with the exception of one-seventh reserved for the support of the clergy, were granted to Admiral Sir Isaac Coffin, in free and common soccage, as a reward for his services in the American war. The story is that on his voyage homeward, when passing these islands, he requested of Lord Dorchester, who was a fellow passenger, a grant of these islands, some say indeed all the islands in the gulf. At all events he obtained a grant not only of these, but of our own Pictou Island. On the latter his rights were sold out to the settlers, but the Magdalene Islands are still held in the family; having descended to his nephew, Admiral John Townshend Coffin, whose son, Isaac Tristram Coffin, is now the proprietor. They have refused to sell, but grant leases, of two kinds, long leases on fixed terms not exceeding 99 years, and leases without

any fixed term, at a perpetual and unredeemable ground rent. The rents vary from 5s. to 30s. per annum a lot, which may be a few feet of beach overflowed by the sea. Before Coffin's grant was issued much of the land was occupied without title, and the parties claimed their lots by possession. It was only after 1839 that a considerable number accepted leases. These leases were loosely drawn and rents were irregularly paid. So that much contention arose between the settlers and the agents of the proprietors. The result was a large amount of discontent in consequence of which, a few years ago, two or three colonies left owing largely to dissatisfaction with the system. It is said that as many as 600 souls removed, most of them to the northern shore of the St. Lawrence, where the land was much inferior and fisheries no better, but they were attracted by the idea of having their land in full ownership. This is the only part of the Dominion where the system lingers, and it is desirable that it should be swept away. Attempts have been made to buy out the rights of the proprietor. It is admitted that with the expense of agency and the various expenditures upon the islands, the property has never really been of any profit to him. But it would seem that such is the grandeur associated with being lord of so many broad acres, that he has always refused to sell, at least on any reasonable terms. I humbly think that, as the Government has compelled the landlords in P. E. Island to sell and has extinguished the seignorial rights in Quebec without asking the consent of the seigneurs, they should close this question by taking the rights of the proprietor on just and reasonable terms. The whole area, we may observe, is estimated at 100,000 acres, of which one-seventh was reserved for the clergy. This has fallen into the hands of the Government, and is being sold by it.

At the time of the granting these islands, it was estimated that there were 100 families upon them, but this is probably an exaggeration. In 1821 Bouchette estimated the number at 138. In 1831 they were estimated at 153, numbering 1,000 souls, though Coffin, in 1839, states that there were only 600 on the whole seven islands. By the census of 1850 they numbered

2,202, and in 1860 had increased to 2,651. By the last census they numbered 4,316 and may now be estimated at 5,000. During the present century a number of English-speaking and Protestant settlers have taken up their abode here. These were principally from P. E. Island and the counties of Pictou and Shelburne in Nova Scotia. From time to time persons wrecked here have chosen to make it the place of their permanent abode. Of such I found English, Scotch, Welsh and Jerseymen. In these ways there has been formed an English-speaking population of over 500 souls.

Before, however, referring more particularly to the people and their industries, we must give a particular account of the islands. The first which meets the eye of the voyager approaching either from the south or east is Entry, so named because it stands as a sentinel at the entrance of Pleasant Bay. Its appearance as you draw near is somewhat striking. On the north-eastern side conical hills rise high above the surrounding waters, one being 580 feet high, and the highest point on the group, while another known as Pig Hill is only 50 feet lower. On this side the sea has so cut in upon it that the cliffs are of a height of 300 and 350 and in one place 400 feet in height. Curiously enough they actually overhang the sea, which has undermined them, and will continue to do so, till the weight of the overhanging mass brings it down with a crash. Toward the south-west, however, the land slopes to the shore. This island is about two miles long, being pentagonal or somewhat circular in shape, but seldom can as much variety of scenery be found in the same space. These hills, and they are but hills, rising abruptly from so small an area, and from their steepness looking higher than they are, give the impression of a rugged and mountainous region. From these radiate miniature gorges and dells, thickly overgrown with bushes, mostly of scrubby spruce, and terminating except on the land-ward side in the magnificent cliffs mentioned, which we now see to be scarped and sculptured into various fantastic shapes. In one place the rocks stand in the form of huge rugged columns, to which have been given the name of the Old Man and Old Woman. At another a portion of about an acre in ex-

tent has been nearly severed from the rest of the island, and is known as Devil's Island.

Ascend to the top of the highest hill and the prospect is one of rare beauty. Southward you gaze upon the ocean, and in the distance you can in suitable weather discern St. Paul's Island and Cape North, in Cape Breton, fifty miles away. To your right and left are the red and grey cliffs of the neighbouring islands, while at your feet to the south-west the island slopes away to the sea, forming beautiful meadows or fertile fields, yielding rich crops of potatoes, grass or grain, rendered still more picturesque by bits of woodland intermixed.

There are ten families on the island. With its rich soil they enjoy to the full the ordinary comforts of life, and without excessive toil. One sees in proportion to its size abundance of live stock, troops of their ponies, droves of pigs wandering at their sweet will, flocks of sheep sometimes grazing on the tops of the highest hills, and plentiful herds of cattle. But beside farming, fishing and lobster canning are carried on. There is no harbor on the island, and it is only at certain places that boats can land, and in stormy weather all intercourse with it is cut off.

There is a passage on either side. That to the north-east is seven miles wide and separates it from Alright Island, that on the south-west is three miles wide and separates it from a sand beach four miles along, known as Sandy Hook, which makes out from the south-east point of Amherst Island. Inside you are in a beautiful bay nine miles wide, known as Pleasant Bay. In summer it dos not belie its name. Its water appeared to me of a lighter greenish hue, and more pellucid than we see in the waters around our Nova Scotia shores. This bay forms a safe and commodious roadstead, except in easterly winds, and there are many pleasant sights around. But it, too, has its tales of sorrow. A gentleman told me that he has seen a fine ship leave in full sail one morning, and before the next day had passed, she was lost with all on board on the back of Sandy Hook beach.

The steamer weekly visiting these islands, first calls at Amherst, which is the largest island of the group. It was so called after

the British General of that name. It lies about east and west and is eleven miles long by about four at its greatest breadth, and on the average not more than two. It is compared in shape to the human foot. On the instep are two conical hills known as the Demoiselles, which I am informed show evidence of volcanic origin, the highest of which has a sea-cliff 280 feet high. At the foot, along a crescent-shaped cove, and straggling up its slopes, are some fifty or sixty houses, forming a sort of village, which is the capital of the island. Here is the jail, for the people are not without that engine of civilization, though among such a quiet people it must be only as a measure of precaution, or for the use of foreign visitants, among whom before the abrogation of the fishery treaty, American fishermen specially claimed its hospitality. Here reside the collector of customs and other officials. At this cove the landing is effected. There is no wharf here or at any other place on the island, so that landing is often inconvenient and sometimes dangerous. The reason given by the inhabitants for not having some wharf or pier is that no construction of the kind will stand the pressure of the ice. The Dominion Government, at the time of my visit, were building a breakwater on one of the other islands, but the first structure was carried away, and many doubt the permanence of this. Farther along we see stores and stages for drying fish, and the entrance to a harbor known as Harbor Aubert, a small and perfectly safe port, the best on the islands, but its entrance channel is narrow and shifting, and it is accessible only to vessels drawing under 12 feet of water.

To the west the island is hilly, rising to an elevation of 550 feet, and falling in gentle slopes to the north. It is partly wooded, but is generally arable and much of it under cultivation.

In connection with this island must be noticed the remarkable rock, known as Deadman's Isle, which lies nine miles to the west of it. It is a bare solitary rock about a mile long, having neither bush nor herb, nor even a blade of grass upon it. It rises with a razor-like ridge at the height of 170 feet.

At a distance, approaching it from some directions, it has the appearance of a gigantic corpse, lying upon the surface of the water, three protuberances representing the feet, the abdomen and the head. But doubtless it deserves the name for a sadder reason. Who can tell how many gallant men have gone down to death in the pitiless waves which beat on its sides? The fisherman lands upon it to cure his fish, but still regards it with somewhat of the superstitious awe, which has prompted the lines of the poet Moore:

"There lieth a wreck on the dismal shore,
Of cold and pitiless Labrador,
Where under the moon upon mountains of frost,
Full many a mariner's bones are tossed.

Yon shadowy bark hath been to that wreck,
And the dim blue fire that lights her deck,
Doth play on as pale and livid a crew
As ever yet drank the church-yard dew.

To Deadman's Isle in the eye of the blast,
To Deadman's Isle she speeds her fast,
By skeleton shapes her sails are furled,
And the hand that steers is not of this world."

From Amherst Island two ridges of sand extend northwardly a distance of nearly eight miles, till they reach Grindstone Island. The western starts from the extreme west of Amherst Island, the other from a point about three miles to the eastward, but they converge as they approach Grindstone to less than a mile and a half. Each of them is broken through by the sea, but still these openings are fordable by vehicle in moderate weather, though it requires the guidance of some person acquainted with the shoals, otherwise one might be carried into deep water or sink in quick sands. The waters enclosed by these is known as Basque Harbor, but it is of little value from its shallow, narrow opening, though it used to be a favorite spawning ground of the herring.

Grindstone Island derives its name from a rounded hill of grey freestone, forming a cape some three hundred feet high, to which the French used to resort for grindstones. Looking at it from the east, it has a remarkable resemblance to a human face with

a tear dropping from the left eye. This island is somewhat oval or tortoise-shaped, its greatest diameter from north to south being about five miles, and its least about four. Its surface exhibits a beautiful variety, hills covered with wood rising to the height of 550 feet, slopes rich in agricultural produce, shores descending to beach or marsh or rising in cliffs steep and inaccessible. It has no harbor of its own, but to the north-east sends out a gravel beach, opposite to which the island of Alright sends out another, leaving a very narrow passage between them. Inside of these is formed a harbor known as House Harbor. But the entrance is narrow and tortuous, and it is only suited for boats or small vessels.

Alright Island, exclusive of its beaches, is about four miles in length by about two in width. Its surface is uneven, consisting of rounded hills with intervening hollows, and in beauty and fertility it is not the least interesting of the group.

From the north-west of Grindstone, in a north-eastwardly direction for twenty-two miles, or till it reaches the north cape of the Grosseisle, extends the most remarkable sand beach on the group, with the usual sand dunes.

Near the centre of it is a small elevation covered with wood and less than half a mile in diameter known as Wolf Island. From the north-east corner of Alright a similar ridge from 500 to 2000 yards wide extends in the same direction for nineteen miles, where there is a passage known as the Grand Entry. Between these two ridges is a quiet bay at least twenty miles long, once navigable for small vessels, but now having a narrow winding channel fit only for boats, except at high tides. The tops of these sand ridges are scantily covered with sharp speared salt grass, but on the southern ridge soil has been partially formed, and we observed it to be covered in many places by shrubbery and dwarf spruce.

Grosseisle in its wider sense embraces four islands, commonly but improperly so-called, as they are united by marsh or sand beach. These are known as Coffin's Island, East Island, Grosseisle, and North Cape. The first of these lies to the east of Grand Entry, and contains the largest extent of upland, being

four miles long and about one broad. The surface is generally high and uneven, steep hills and deep hollows, with sometimes small lakes, succeeding one another. To the north it is connected by a sand beach with the East Island, which is about four miles in length by about two in breadth. Though this has one cliff 240 feet high, it is generally low-lying and marshy, and much of it is occupied by shallow lakes. Grosseisle, which is again joined to it at its north end by a sand-ridge, is smaller, being less than two miles in length by less than a mile in breadth. It forms, however, the most prominent object in the landscape, being quite elevated and being distinguished by three or four conical peaks, which form cliffs over 300 feet high. These have suggested the name. From the summit of any one of them the view on a summer day is one of surpassing grandeur. North Cape is a small circular island about half a mile in diameter, joined to Grosseisle by marsh and sandy beach.

The shores of this group, if I may call it so, present a varied and often very striking appearance. Besides the high cliffs of Grosseisle, there are others as at North Cape, Old Harry Head, and East Island, between two and three hundred feet high, and sometimes worn into rugged or even fantastic shapes. Then there are miles of sand ridges, inside of which are peaceful lagoons, while again the low-lying sea-board, with reefs extending for miles seaward, and sometimes spurs of sand, covered with shallow water, is sometimes more dangerous to navigators than even the loftiest cliffs.

In that part of this island which I saw, the soil did not seem as good as on the others. In some places I saw sub-soil of white sand, on which the growth and decay of vegetation had formed a peaty mould. But still the crops were generally fair, The inhabitants subsist mainly by the fisheries, but the most of them cultivate small plots of land, from which they receive a good return according to the labor bestowed upon them. Much of it is still covered by wood, stunted in dimensions.

All these islands from Amherst to Grosseisle were formerly, and perhaps sometimes are yet, spoken of as one, the Magdalene

Island, they being with the exception of Alright all connected by marsh or sand-beach.

Ten miles to the northward lies Bryon, four miles long, lying nearly east and west. As we approach from the south, the appearance of the island from the water, with its dark brown cliffs, its sloping hills rising to the height of 200 feet, with occasional farm steadings, but the greater part dark green with spruce and fir woods, is quite picturesque. One thing that struck me, however, was the peculiarly stunted appearance of the trees. On all the islands the wood is stunted, owing, no doubt, to the ocean winds. But this island is very narrow, not more than three-quarters of a mile at its greatest breadth, and it appeared to me in some places not more than one, and having no other land near it, is particularly exposed. So that the trees appear along the shore often as dead or dying, or as thick bunches, so close that no bird could penetrate them, and in the interior as if the tops were cut off, about twenty or twenty-five feet from the ground, and the branches extending horizontally, as we have seen the cedars of Lebanon represented.

There is no harbor on the island and few convenient landing places. The best are at two coves on the south side,—one near the east end and the other near the west. At other points there may be narrow margins of beach at the foot of cliffs perhaps a hundred feet high, where one may land, but in such cases one can ascend or descend, and goods can be hoisted or lowered only by ropes. But in rough weather there is no landing upon any part of it.

This island, however, is perhaps the finest for agriculture of the whole group. It presents beautiful slopes, with a fine deep soil. Here farming is conducted on a larger scale than on any of the other islands, mine host keeping eighteen cows, and his brother alongside of him twelve, all of which were in excellent condition, and improved by crossing with imported cattle of superior breeds, besides other stock of good quality, contrasting strongly with the stock on the other islands, which is commonly of the poorest. These men, who were originally from P. E. Island, represent the soil as superior to that of the latter. Yet,

still they give their attention to fishing to the neglect of their farms.

Northeast, about eighteen miles from Grosseisle, and twelve from Bryon, lie the Bird Rocks, distinguished as the Great Bird and the North Bird. They of course derive their name from the immense multitude of birds that frequent them. Though I was not nearer than twelve miles and evening was approaching, and there was besides a slight haze towards the horizon, I could distinctly see the greyish-white color (by visitors they are described as white as snow) from the large number of the birds which make their nests upon them, particularly the gannet. This bird is about three feet long, white in color, except the top of the head and the back of the neck, which are tinged with yellow, and the quill feathers, which are black. They possess great power of flight. They are round us now miles from their home, and it is interesting to watch them as they soar aloft, and then, folding their wings close to their sides, dart down with unerring aim and seize their finny prey beneath the waters, and then with a few flaps of their wings on the water, quickly rise again. When a shoal of herring approach the shore, the scene is said to be very animated, thousands of these birds gathering like a white cloud over the spot, and seeming like a stream of shot pouring into the sea as they plunge into the waters and rise with their prey glistening in their beaks. On these islands their nests are so thick, that in appearance the surface is compared to a field of potato hills. In consequence, the visitor has his ears dinned by the horrible clamour, while his olfactories are offended by other results of their presence. I may add that all the islands afford a fine field for the pursuit or study of birds. On Grindstone Island, a visitor in one day killed ninety-five of eighteen different species.

These islands rise abruptly to the height of 140 feet, their sides having a shelving or terraced form. It is only in a calm state of wind and sea that a landing can be effected. On the Great Bird, in connection with the light-house there established, there is an arrangement by which visitors as well as all supplies are hoisted to the summit by a crane. In size they are too small

to be of any importance, the smaller consisting of rocks protruding from the sea, and the largest containing an area of only four acres. They are about a mile apart and the water between them is shallow, while from the North Bird a rocky shoal extends about a mile farther. So that this too has been the scene of shipwrecks, of which often neither person nor thing has been left to tell the tale.

About 25 years ago a magnificent iron ship of the Allan line was cast away here and soon went to pieces. There is now a lighthouse, however, upon the Great Bird, with fog gun, and also connection by telegraph with the other islands and the main land. The keeper, his wife, and two assistants, all Magdalene Island French, are the only inhabitants of the islands, and a lonely position they must have.

After 1763 the British Government ordered a survey of these and other islands in the Gulf, under the direction of Major Holland, appointed Surveyor-General of the northern district of the B. N. A. Provinces. The service was entrusted to Lieutenant F. Haviland, and as the result of his work, Mr. H. sent a description of the islands to the British Government in 1798, at the time of the granting of them to Coffin. In this report they are estimated as containing 60,000 acres. One-seventh being reserved for the support of the clergy, Coffiin's Island as containing about that proportion of the whole was set apart for that object.

The area, as thus stated, however, was less than the reality, for, by the survey of Mr. Desbarres in 1778, and the later of Lieutenant Collins in 1833, it was reckoned at 78,000. But the resident agent of the proprietors informed me that it was really 100,000.

Returning to notice the natural history of these islands, I may say that the only mineral known to be in sufficient quantities to be of economic importance is the gypsum, which lies along the base of the Trappean hills which serve as the nucleus of the principal islands, and forms a considerable extent of the sea cliffs. On land it may be traced by the number of funnel or cup-like depressions formed by the solvent action of the water penetrating the fissures. Some of these are dry, others contain water, in

some instances, so deep that the people declare that they are bottomless. Some curious things are told in regard to these deposits. A man digging a well, when he got into the rock bored a hole, charged it with powder and fired it off. To his surprise, instead of blowing up it blew down, and smoke was seen issuing from the foot of the cliff near by, exciting some superstitious fears in the minds of the actors. Formerly it was mined in considerable quantities and exported to Quebec. Limestone is also found, but I believe in quantities too small to be of economic value.

Of quadrupeds, the indigenous animals are the fox, the rabbit or American hare, and the field mouse.

Of reptiles, we might write the chapter which a writer did on snakes in Ireland, which merely contained the statement: "There are no snakes in Ireland." There are said to be no snakes, lizards, toads or frogs on the Magdalene Islands.

When these islands were discovered, they were well covered with wood, and formerly vessels of some size were built upon them; but the most of it has been cut away or destroyed by fire, and what remains, being in narrow strips and exposed to the sea breezes, is stunted. Formerly, there was good birch and other valuable hard wood. Now there are scarcely any trees to be seen but spruce and fir of second growth, very stunted. This for some time has been the only resource of the inhabitants for fuel, and it scarcely serves any other purpose. But on Entry and Alright even that is nearly exhausted, so that the inhabitants are beginning to use coal, and on all the larger islands they will soon require to do so.

We have already mentioned that the soil is of the best quality, but there is scarcely any proper farming. Each family generally has a piece of land from which they take some crops, but the cultivation is neglected or left to the women. Hay will be taken off the same ground for a generation without its being ploughed. Their animals are of the poorest quality. Sheep look like lambs of from four to six months, though to do them justice, they show a skill in climbing cliffs such as we have hitherto supposed the gift of goats. Then, their pigs, which run

about everywhere! If we want to see extinct animals, still in the flesh, look at those slab-sided, long-legged creatures with subsoil snouts, who seem almost lords of the soil. One reason given for not attending better to their farming is that they have no mills to grind their grain, or even to card their wool, there being no streams on the island continuous enough to maintain one. But this need not hinder, but should rather encourage attention to their stock. And it has been suggested, that the want of water power might be easily supplied by windmills, of which the motive power is at hand in abundance.

But fishing is really the great business of the inhabitants. The time is not long past when their fishing grounds were the most productive perhaps in the world. Men scarcely past middle life tell of seeing three hundred vessels off their shore at one time, and getting full cargoes in a few days, or of Pleasant Bay being so packed with herring that men had only to dip them up till their vessel was full. These days are past, but still fishing is the principal employment of the people.

The first in March and April is the seal hunting. As the time approaches men ascend the highest hills, and eagerly scan the ice round the shores for a sight of the black forms, which are easily discerned at a long distance. When the word is given that they have appeared the news spreads like wild fire. It is celebrated by the ringing of bells and firing of guns, and the whole inhabitants are roused to feverish excitement. From every quarter men make for the ice, armed with knives and clubs. Even the women gather at the shore where they prepare warm meals for the men, and perhaps help in skinning the seals after they are landed. The men go out on the ice, taking with them small flat-bottomed boats usually called flats, in case of the ice parting. Then goes on the slaughter and afterwards the dragging the dead bodies to the shore, the latter, very laborious work. The work is also not without danger. The ice may break away from the shore ice with the wind and carry the unfortunate fishermen to sea. Seal fishing is also conducted with nets made for the purpose of strong cord with large meshes. If the ice moves, so that the hunting cannot be prosecuted from the

shore, it is followed to sea in schooners fitted out for the purpose.

The sealing is, or was, followed by the spring herring fishing. In former years these used to come in immense numbers. In Pleasant Bay alone 50,000 barrels have been caught in fifteen days. But for some cause unknown they have for some time almost forsaken their old places of resort, so that the people now catch hardly more than enough to serve them as bait for their lobster traps.

In the beginning of June come the Spring mackerel. Like the herring, they come to spawn, and are then poor. In a fortnight they return to deep water, but they return again about the last of July or first of August. They are now large and fat, and for the next two months move capriciously round the islands and neighboring coasts. In past years great quantities have been taken both by American and Colonial fishermen. In the year 1875, a year not very profitable, 200 American vessels took 30,000 barrels, worth at a low estimate $350,000, while the islanders cured 9,000, valued at $100,000. But for the last few years these fish have almost forsaken their former haunts.

The codfish has been a more steady and stable resource. From the time when the islands were discovered, they have been caught in large numbers, and though they will be more plentiful in one year than another, yet they have never entirely failed. The fishing is prosecuted from the beginning of May till the end of October. In 1880, the year of the last census, the catch amounted to about 18,000 quintals.

Within the last few years the canning of lobsters has become one of the staple industries of the islands. Establishments for the purpose have risen on every part of the group, which for a time did a flourishing business. But it is evidently overdone. Not only has the number taken fallen off, but, with perhaps the exception of one place on Bryon Island, where an establishment has just begun, those taken are very small, and the meat thin, so that I was informed that it would take about eight lobsters to fill a pound can. Indeed, I believe that the greater part of those taken were below the size allowed by law.

Other fish abound, though the taking of them is not of great economic importance. Halibut are caught in deep water; occasionally porpoises are seen spouting; sea eels are speared in the lagoons; smelts come up the streams in great abundance, and splendid sea trout are caught at the head of them.

But no person once visiting a fishing station at the Magdalene Islands, can forget the sights and smells which there regale his senses. Take as a typical example Etang du Nord (in English North Pond) corrupted in Tandanore, a small haven for boats on the west side of Grindstone Island. The view is picturesque as you approach, or view it from higher ground, as is generally the case with all the fishing stations. But nearer approach dissipates sentiment. Here is the lobster canning establishment. Shall we enter it? Inside it is rough, and things don't look inviting, but it is said that every thing about the work is quite clean, and you can convince yourself of the fact. But outside, if not within, you will see what will have a tendency to diminish your relish for lobster salad next winter. Only the meat in the claws and tail of the lobster are used. The bodies are thrown out and pigs are enjoying high festival. But go a little farther and you meet a semi-circular row of little huts set on pillars in the sand and used for storing fish, and huts scarcely any better, in which the fishermen with their families come to live during the fishing season. Here is a group of women chattering as only French women can, sitting on the sand shelling clams for bait, while others in carts are bringing them in the shell from where they have been dug, others may be engaged in the operations necessary for the curing of codfish, disembowelling, splitting, salting, drying and piling them. Boats are landing their catch either of codfish or lobsters. But upon all this offal pigs are feeding in dozens. But I am afraid the effect of the whole scene on another of your sense will be likely to cause you to lose the benefits to be derived according to some sanitarians to your brain and bodily health, by a diet of salt cod. Perhaps you may even be tempted to become a Jew as far as prejudice against pork fed on these islands are concerned.

How this state of matters does not breed a pestilence we can-

not imagine. Perhaps it is that the constant breeze from and to the sea purifies the air. Certain it is that men, women and children live among these scenes and presume to be healthy.

Having referred to the women, I may here say that of all the industrious creatures I have seen, the French women bear the palm. Besides their help in the fishing, the cultivation of the land is largely their work. Besides their household duties they spin the wool on the old fashioned wheel, weave it into cloth for themselves and their families. And as for knitting it would seem an unpardonable waste of time, to go along the road even a short distance without the knitting needles being in operation. See two girls driving along the road in one of their little carts; while one drives the other is adding some rounds to the stocking. And as might be supposed they are not extravagant as to dress.

As a people, we may say they are generally temperate. There are no places where liquor is retailed. Some of the large traders do not supply it at all, and others only import small quantities to be used for special purposes. Doubtless it is imported otherwise, but still its use is comparatively limited. But on the other hand, tobacco is regarded almost as the staff of life, and in the use of tea they excel even the people of Nova Scotia.

Notwithstanding the resources of the island, the majority of the inhabitants have been kept in a state of comparative poverty. While this probably was owing in some measure to want of thrift, yet the system of dealing, combined with their want of education, tended to the same result. Every person in spring went in debt to the merchant for supplies, and at the end of summer gave him the proceeds of his fishing. The latter gave him no account, as he could neither read nor write, but told him that he was clear, or that he was still in debt so much, and they commenced the same process again.

In the year 1882 they almost suffered from famine. The year before the potato crop failed. A vessel sent to Quebec with their fish and to bring back supplies, foundered, and by spring they were reduced to the verge of starvation. Flour was not to be had at any price. The rich could not help the poor. The first relief was by a vessel bound for Newfoundland, which was wrecked on Grosseisle.

With their want of education they are extremely superstitious. They believe firmly in the power of the Devil, and tell seriously of men bargaining with him, or of his fishing with them a whole season in the disguise of a man, and perhaps relate with some satisfaction some clever trick by which they outwitted him.

While many of the old can neither read or write, the young generally possess the first and perhaps both of these accomplishments. I am informed, too, that there is a desire among them to learn English, as they feel the disadvantages of being unacquainted with it. I may add that they and their English neighbors have always lived on terms of peace and kindness—and that there is no spirit of violence among them. I may say also that there is much of French courtesy among them. You never meet a boy on the road without a bow that a Parisian would not need to be ashamed of, a touch or lifting of the hat if he has one, and a polite *Bon jour*.

The English are superior in intelligence and as a class in wealth. And though they do not amalgamate with the French they have become very much assimilated to them. They occupy almost entirely Entry, Grosseisle and Bryon Islands. The French occupy Amherst, Alright and Grindstone, though there are about 30 English families mixed up with them, principally on the last mentioned. They number over 4000. They have three chapels, with as many priests, and, besides their churches have to maintain convent schools. With the failure of the fisheries of late years, the maintenance of all these has been felt a burden.

There are three Protestant churches, all small, on the islands, one at Amherst, one at Grindstone and one on Grosseisle. They have been for some years supplied by a Church of England missionary. Under the Quebec school law, they have separate schools on the two last mentioned islands.

And now a word in conclusion, as to political or civil affairs. They are divided into three parishes—Amherst, which includes Entry, Grindstone, and Alright, which includes Grosseisle and Bryon. The civil affairs of each are administered by a council of seven. The three mayors form a county council, though other-

wise they form part of the County of Gaspe, in the Province of Quebec.

In conclusion, I need not say that by my short visit to these islands I have been much interested in the place and people. Their physical appearance attracted the eye of the lover of nature; naturalists are attracted by the opportunities they afford for studying the creatures which people the land, the air and the waters; the seeker after rest and health may find here a quiet retreat from the world, and a climate conducive to vigor; the political economist may find here resources which rightly improved would yet add materially to our national wealth, while the students of man will find much to enjoy in intercourse with a simple minded and hospitable people.

VI.—Notes on Some Explosions in Nova Scotia Coal Mines.—By E. Gilpin, Jr., *Inspector of Mines.*

The presence of notable amounts of gas in the Nova Scotia coal mines seems to have been noticed first in Pictou Co. Here mining operations were commenced systematically in 1827 in the main seam, from 28 to 35 feet in thickness and dipping at an angle of about one in three. The early workings were from shafts up to 150 feet in depth. As deeper shafts were sunk the height of the working places, nine to twelve feet high, was increased to nearly the full height of the seam, Large quantities of gas were given off, and it was frequently ignited by shots. Numerous explosions took place, until about the year 1870 all these older workings were abandoned and operations in this seam were confined to the Ford Pit shaft about 900 feet deep.

The last of these fires took place in 1867. The eastern district had been for some time giving off gas which had occasionally been ignited on blasting the coal, but had been easily extinguished. On this occasion the gas took fire among the coal brought down by a shot, and the efforts made were not successful in putting it out. The coal caught fire and the water of the East river was turned into the pit.

When the Ford pit was sunk to the main seam and the levels were being opened a shot fired gas and ignited the coal and the shaft had to be closed for some time.

There remains but little information about these fires and explosions. Generally speaking, the workings were damp, except in some of the working places in the lowest deeps. The ventilation, by furnace, with upcasts of about 300 feet, was not able to sweep the huge chambers in this thick coal, and large bodies of gas constantly accumulated. It is probable that the imperfectness of the ventilation, by allowing vitiated

air to mix with the gas, rendered it less explosive. It is stated that on one occasion the exudation of gas was so steady and strong, that on removing it by a heavy fall of water, it fired at the boiler fires on the surface some fifty feet from the shaft. The resulting fire was so strong as to practically fuse and destroy the shaft.

In Cape Breton, up to this date, there had been a few slight explosions but no serious accidents. The Mines Report for 1890, gives special rules in force in Pictou County in 1840, which show that the presence of gas in these mines was regarded as constant.

One explosion before 1870, in the Deep or Cage pit, was undoubtedly of gas only. It took place in the face of a level which was wet for some distance back from the face. The explosion was local, and the timber of the place and the man who fired the shot were badly shattered.

In 1873, at the Drummond Colliery, Pictou County, a shot in the bench coal set fire to a heavy feeder, which could not be put out, and the pit was set on fire and greatly damaged after a series of unusually heavy explosions. It is not believed that coal dust was greatly concerned in this explosion, as it is believed that the gas made by the pit and the fire were enough to account for all the explosions. About fifty-five lives were lost.

May 21st, 1878, an explosion occurred at the Sydney Colliery, Cape Breton Co., by which six men were killed. Gas was fired at the face of a working place, by a party of men, including the overman, who were arranging to start new work. The effect of the explosion was very slight at the seat of the explosion, but its effects began to be felt a few yards away, and for some distance the coal and props were charred, and the latter knocked out. The amount of gas presumably must have been very small, as there was a head within two feet of the face. The workings were dry and the roadways deep in dust. In this case there appears to be no doubt that the coal dust augmented the explosion, which sent dust up the shaft at a distance of nearly 3,000 feet.

The coal of the Cape Breton coal field presents the following

average composition (from a paper read by me at the Montreal meeting of the British Association):

Moisture	0.75
Volatile combustible matter	37.26
Fixed carbon	58.74
Ash	3.25

These coals coke readily, and yield from 8,000 to 11,000 cubic feet per ton of illuminating gas of from 10 to 16 candle power.

On November 12th, 1880, a very violent explosion took place at the Foord Pit, Albion Mines, Pictou Co., referred to above, causing the loss of forty-four lives. The men had descended in the morning, and the greater number of those employed on the south side had left the bottom, and presumably were gathered at the head of the dip-slants about three-quarters of a mile away waiting for their tools, when the explosion took place. These dip-slants are believed to have been the seat of the explosion, which, reaching the levels, divided, part going to the rise of the upcast and part coming direct to the main shafts, downcasts.

The theory was advanced that the shot firer had fired a shot in one of the places in these slants, which had been left by the outgoing shaft, and that it had lighted gas. No exact account, however, can be given, as no one escaped from that side of the pit and it has not since been entered. There is a possibility that some gas had accumulated since the examination of the foreman, and had been ignited by some of the men going into their places, without waiting for their tools, to load coal, timber, etc., as the time gave scant opportunity for the shot firer to have fired the shot. The mine was pronounced that morning free from gas, except in very small amounts lying away from the district in which the explosion was believed to have originated. From what source, then, started the series of explosions, beginning within an hour from the time the mine was reported entirely safe, and continuing at intervals until the mine became a furnace whose flames could be subdued only by emptying into its burning chambers the waters of an adjoining river. The locality where the men were believed to have been gathered was about

1200 yards from the shaft, but only half that distance could be traversed by the explorers, who entered the pit between the first and second explosions. In this distance were found bodies of men and horses killed by concussion or after-damp; but none bore the mark of fire, nor did the splintered woodwork show any signs of charring. and the flames had not reached this part of the mine. The walls of the main level had been swept clear of timber and of every particle of dust. Volumes of coal dust had been driven into this section by the blast, and lay in waves and drifts, sometimes a foot thick, in the floor of the level.

It was found that little of this dust showed any signs of heat or coking. Clouds of the finer particles had evidently been carried along the main and low levels past the shafts and into the north levels. Here a lamp cabin had been built, in a head between the two levels, a few yards from the pit bottom. There was a secondary explosion here demolishing the lamp cabin, burning fatally the lamp man, and the horses between the cabin and pit, and showing markings of fire, while in the opposite or south side of the pit, as already mentioned, there were no signs of the passage of flame.

Secondary explosions, caused by generated or extracted gases, are usually in the vicinity of primary explosions. But in this case it had apparently taken place at least one half a mile from the first explosion, with the intervening spaces evidently untraversed by flame, and presumably free from gas, as they had been worked many years. The shaft and bottom were very wet, hence the dust as it touched the walls became innocuous, but the fine dry particles of carbon were driven into the lamp cabin.

It had been the custom for years to keep a large open oil light here, as the cabin was near the pit bottom and in fresh air. But on this occasion it would appear that ignition of coal dust caused an explosion comparatively slight in comparison with the one preceding and those following it. It may have been the case that the air and dust were intermingled with some gas distilled by the heat of the primary explosion, but not exploded by it.

The coal took fire presumably near the first explosion, and the shafts were saved only by the most strenuous efforts and the

introduction of water from the East River. The main seam, as worked by the Albion, Acadia, and Drummond Collieries, was always gassy, and became dry a short distance away from the crop. It appears, also, that when shots lighted gas, or upon any explosion, the coal ignited very readily.

The average composition of the coals of this district, taken from the paper referred to, is:

Moisture	1.19
Volatile combustible matter	29.10
Fixed carbon	60.63
Ash	9.34

The coals are firm, and hold a good deal of mineral charcoal. They are generally coking, and yield from 6,000 to 9,000 cubic feet per ton of 12 to 15 candle-power gas.

February 18, 1885, an explosion causing the death of 13 men took place in the Vale Colliery, Pictou County. It was claimed by the management that it was caused by dust alone from a blown out shot. However, a very careful enquiry conducted by the Deputy Inspector, Mr. Maddin, showed that it was with more probability due to a small body of gas extended by dust. I give verbatim his report which was based on our careful examination of the seat of the explosion, a very full enquiry, and the general consensus of opinion of the most experienced mining engineers of the district.

"I was in Cumberland County at the time and arrived at scene of disaster on the 12th, and remained for some length of time investigating the cause of the accident.

"On April 6th I went down the McBean seam to the point where the men had been working at the time of the explosion, examined a hole at that point which was supposed to have been fired on the night of the explosion, and which some of the officials consider caused the explosion. The cause of the explosion at the Vale Colliery is a matter of dispute amongst experts. but the most reasonable solution appears to be as follows: On the west side of the slope, at 1300 feet level, were two (2) check doors, which, when shut, sent the air circulating down the slope,

but if opened the air would rush to the upcast, as an exhaust fan is situated on that side and thus the lower part of mine would be cut off from the air communication which, if allowed for any length of time, would undoubtedly accumulate gas; from appearances I would judge this to have transpired and gas to have been generated in the manner supposed. Gas then having been driven down by the restored action of the air was forced upon Foley's lamp, who was working in a head about 100 feet from sinking face. He was burned almost to a crisp, whilst two-thirds of the men below him had scarcely a singed head. Whilst sinking, they drive heads east and west from back slopes, at intervals of about 60 feet, at right angles to slopes, which are cut again at the face, coming up the hill with shoots. Heads driven up the hill, off the air current any distance, and left standing, will fill with gas. This has been an occurrence before the explosion, and since, which would lead me to believe that the air current must have in some way been tampered with, and the restored action resulted as I have stated. In support of this view I would say that the timbers in the slopes from the head in which Foley worked "downward," that is, toward the sinking face, gave unmistakable evidence that the explosion came from above, whilst the timber above this head gave like evidence that the explosion came from below, until it reached the 1800 feet level, which is some 400 feet above the level; then it expanded east and west, destroying the check doors on the levels, and showing slight signs of the explosion for a distance of 200 or 300 feet in the levels inside the doors, which were from 70 to 100 feet off the slope. The stoppings between the main slope and back slopes from the level up to the 1300 feet level were blown down. Strange to say, the first check door at 1300 feet level, on west side, was found standing open, whilst the inside door was destroyed. At this point there were men employed taking timber from the slope to some point inside of the doors. The explosion had gone in this level a distance of not more than 200 or 300 feet. The stoppings from 1300 feet level to mouth of slope were blown down, and timber and debris were strewed in a confused way all through the slope."

The force of the explosion seems to have been spread over the area I have mentioned, viz.: on the main slope and back slopes, and extending east and west from main slope a distance of from 200 to 300 feet, over which area the timber was in many cases blown down and falls of roof took place, whilst the working faces on east and west side of pit were free from any appearance of explosion and in as good order after as before.

After the mine resumed work and the water was extracted, a hole was discovered at the working face of the sinking. The evidence brought to show that this hole was fired, before the explosion, did not appear conclusive.

On January 15, 1887, an explosion took place at the Third Seam workings, Stellarton, Pictou Co., fortunately unaccompanied by loss of life. This explosion, which was considered one of the most violent ever known, was accompanied by unusual circumstances.

Preparations were made for beginning a slope in the Cage Pit or Deep Seam to the rise of the old shaft, to strike an old balance near the east level workings, in order to win the coal to the northeast of the present workings. This project unfortunately was prevented by the discovery that the fire in the west rise workings of the Cage Pit was not extinguished. The fire had been built off, I think, in 1872, and it was believed by the management to be quite out, especially as the fire in the same mine, caused by the Foord Pit explosion, was found to be out when the mine was re-entered. During the summer, part of the pillars in a balance in the Third Seam workings under the Cage Pit seam had been drawn, the fall of the roof extended up to it, and stythe came into the Third Seam workings. The balance was isolated by stoppings, and at the close of the year no trouble was anticipated. In the beginning of this year, however, fire broke out in the Third Seam with great violence, destroying the bank-head and necessitating the closing of the mine.

The extraction of pillars in the lower seam had broken the roof up to the overlying or second seam. As stythe came down, the panel or back-balance in which the pillars had been drawn was built off as rapidly as possible. For about a month every-

thing appeared to be all right, and the temperature of the panel lessened. Then, one Sunday morning, smoke was found in the return, and shortly after a most terrific explosion occurred, which wrecked the slopes and set fire to the bank-head, which was destroyed in a very short time. The immediate origin of this fire is unknown, but it is conjectured that a fall of roof had broken one of the stoppings, and the admission of fresh air had caused the ignition of gas slowly distilled from the heated shales, etc. Presumably, the explosion was heightened in its effects by dust, although the mine would not be classed as dusty.

I append the following from my report on the explosion at Springhill, February 21st, 1891. (See Report of Mines Department, year 1890.)

In the No. 7 balance when the bords were first started, the coal was worked to its full height, having a bench of about 4 feet, then a stone band, and above that about 3 feet of coal. After the bords were driven in a short distance, the fall coal and stone was left in and the bench only was worked. This coal was not worked with powder, but as the face advanced it was necessary to blow down from 12 to 18 inches of the stone, to make room for the tubs to get near enough to the face to permit of their being loaded with coal. The stone was blown down in the low side of the bords, over the rails, and stowed in the high side. A row of props along the middle of the bords held the rest of the stone up. There was consequently little shot-firing done in the balance workings. The stone is about two feet thick, a coarse sandstone, with streaks of coal sometimes 2 inches thick. It was shown in evidence that usually the holes for the shots in the stone were bored in the coal streaks and were in some cases partly in stone and partly in coal.

It was shown that on the day of the explosion a shot was to be fired in this stone in the No. 3 bord in No. 7 balance, and that Thos. Wilson, the shot firer, left the bottom of the slope about a quarter past twelve o'clock, saying he had to go to No. 7 balance. The explosion occurred shortly before one o'clock, a time having elapsed in the opinion of the witnesses sufficient to have allowed him to reach this point, to have made the necessary preparations

and to have fired the shot. His body was found, with those of the men working in the bord, near the entrance to the place. The shot in the stone had been fired. This, coupled with the direction of the course of the explosion, showed with reasonable certainty that it had its origin in the bord, and that the shot fired by Wilson was the direct cause of the explosion.

The suggestion was made by Mr. Madden, the Deputy Inspector, who was at hand at the time of the explosion, and rendered valuable aid to the rescuing and exploring parties, that the immediate seat of the explosion was to be sought in the stone itself. After examining the bord in question with him, I am of opinion that his suggestion offers the readiest explanation of the source of the catastrophe.

The bord is 14 feet wide, and the stone is carried by a row of props in the middle. These props were set by the miners as they advanced the face, to hold the stone, which was not of a specially strong character, consequently, as the stone was not blown down until it became troublesome to move the tubs, there were always props along the side of the shots, and between the shots and the face. The effect of these props was to partly confine the shots to the low side of the bord.

As the stone was in layers, and had streaks of coal in it, examination showed that it was more or less fissures across the bord, and hung on the props, the natural effect of the shots being to blow in along the layers, to compress the props and to cause the stone to bag between the props and the high side. That this effect was produced is shown by the fact that large quantities of this stone fell in the workings of No. 7 balance, the props being knocked out by the explosion, although very short, and partly supported by the stone stowed in the high side. The hole that was fired in No. 3 bord was, so far as could be estimated, from 2 feet 9 inches to 3 feet long. The end of the hole was in stone. The charge of powder appeared to have filled 18 inches of the hole. The shot threw down about ¾ of the stone it was designed to dislodge, and left the balance split by the heel of the shot, and a prop near the back of the hole. There was a lype in the stone

on the low side of the bord, which may have helped to lessen the desired effect of the shot.

The weight of evidence appeared to be that there had been an overcharge of powder.

It would appear that the expansion of the layers of the stone afforded space for the accumulation of gas, which would not be readily dislodged by the air current,, and there was an unusual opportunity for accumulation, owing to the fact that the pit was idle the preceding day. That the shot gave evidence of having been a more or less flaming one; that it ignited the gas lodged in the roof stone; that this combination of gas and powder flame acting on an atmosphere charged with a small percentage of gas and fine floating dust derived from the lower bords, caused an intense flame sufficient to propagate itself until it reached an intensely explosive state and self supporting, swept the two balances and the adjacent levels.

The evidence of Enoch Cox, who worked in No. 1 bord, on the same balance, supports this view. He testified that some time previous to the explosion a shot was fired in this stone, that filled his working place with flame, and ignited the gas in the stone, so that it required some effort to extinguish it. It is fair to state that the management declare they never heard of this, and that it was never reported to them.

The effect of dust and gas are referred to therein. This is one of the few explosions that have happened on this side of the Atlantic, where an opportunity has offered for an exact identification of the starting point and for an examination into the results produced. The testimony thus gathered appears to agree closely with the results of previous enquiries in this direction in Nova Scotia, and is to the effect that as yet no explosion here can be traced directly to coal dust fired by powder or by an open light. In this connection the evidence given at Springhill (see Mines Report, 1890) seems to show that when flaming shots took place, both dust and gas were present.

The Springhill coal in character resembles that of Pictou, but is, perhaps, most properly described as intermediate between the Cape Breton and Pictou County coals. It is coking, and yields

fair amounts of illuminating gas. The average composition is about—

Moisture	1.46
Volatile combustible matter	33.69
Fixed carbon	59.35
Ash	5.50

In conclusion, I may say that the mines here are as a rule carefully worked,—that individual or insignificant ignitions of gas are rare; that the amounts of gas now visible in the mines are quite small in comparison with the amounts allowed twenty years ago; that during this period great improvements have been made in the amounts of air circulating, and that it may be the increase in the velocity of the air currents and the larger amounts of air now mixed with the gas, and the greater movement of dust, combine to render explosions more violent in Nova Scotia than they were thirty years ago, when large bodies of gas were common in the mines, but existing as diluted greatly with deoxidised air and the products of combustion and breathing.

When the number of shots fired in mines dusty and yielding gas is considered, and the variety of explosions or ignitions of dust or gas is remembered, in connection with the frequent malignity of explosions when they do occur, it may be permitted to speculate if there may not exist certain conditions (applying to gases) rendering the inception and propagation of explosions more ready at one time than another. To the uninformed mind it certainly appears that in our dusty and gassy mines there should be more frequent explosions when the number of shots fired is considered.

If any means could be assigned for an increased readiness for dust particles or gas to ignite at one time more than another, ground might be given for experiment. When the existence in mines is noted of tracts of dry and dusty workings, alternating with others dampened with moisture, it may not be impossible for electrically induced conditions to be set up in a dry district, as influenced by the neighborhood of a damp and better conducting tract, that may at times present unusually favorable

conditions for ready ignition of gas and prompt distillation of coal dust, and an equally prompt propagation of the induced explosions.

In this connection the following remarks on Explosions in Dynamite Factories, from Eissler's work on modern explosives, are of interest :—

"EXPLOSIVES DUE TO EXTERNAL CAUSES.

"Mr. L. J. LeConte holds that dynamite catastrophies are intimately associated with electric phenomena. He has for the past ten years noted the circumstances attending the accidental explosions which so frequently occur on the Pacific Coast of North America, and he has found that. with the exception of such as occur during thunderstorms, the explosions take place during the violent, desiccating, north wind storms peculiar to the winter and spring months in California, but occasionally happening in midsummer.

"These winds, it must be remembered, have a velocity of 50 miles per hour, and a relative humidity of about 20 per cent., but frequently as low as 15 per cent., though seldom as low as 5 per cent. During the prevalence of the winds a prodigious amount of electricity is developed by the friction of clothing, especially when walking against the wind. One can thus easily generate a spark half an inch long. The phenomenon is also strongly marked in horses at work, the electricity causing their manes and tails to bristle to a remarkable extent. Mr. LeConte finds in the electricity the exciting cause of these explosions, and in the dust that prevails in the work, the medium through which explosion is propagated, a dust explosion always preceding the explosion of the mass of powder.

"The explosions occur on the third or fourth day of the storm.

"To test the theory, he made four predictions in 1882 and 1883, and in each case an explosion of considerable magnitude occurred. To guard against these accidents, he suggests the use of steam jets, such as have been so successfully applied in cotton and flour mills, and in coal mines.

"As explosions during thunderstorms are caused by the retnrn

shock, it should be a fundamental precaution that all good conductors of electricity be prohibited from entering any building where explosives are stored or manufactured; and it would be a wholesome rule not to allow such conductors to be anywhere near the premises."

VII.—On some Lecture Experiments illustrating Properties of Saline Solutions.—By Prof. J. G. MacGregor, *Dalhousie College, Halifax, N. S.*

[*Received May 1st, 1891.*]

(1.) In a paper printed in the last volume of this Institute's Proceedings,* I pointed out that, according to Kohlrausch's observations, sufficiently dilute solutions of sodium hydroxide have volumes which are less than the volumes which their solvent water would have in the free state, one gramme of a solution containing about six per cent. of the hydroxide, having a volume 0.0045 cu. cm. less than the water it contains. Several other substances are known which exhibit the phenomenon of contraction on solution, in a similarly marked manner, but none which exhibit it to such an extent. This hydroxide, therefore, affords the best means of exhibiting the phenomenon of contraction by a lecture experiment.

The simplest mode of conducting the experiment is to pass the powdered caustic soda, little by little, down a glass tube forming a prolongation of the neck of a large bottle, the bottle and part of the tube having been first filled with distilled (or, indeed, undistilled) water. The substance is quickly dissolved by the water, the strong solution thus formed sinks and mixes with the water below, and the change of volume of the liquid is indicated by the change of height of the column of liquid in the tube. In order that the experiment may be made quickly, the powder must not be allowed to form a cake in the tube where it meets the water. To avoid this, a tube of about seven or eight mm. diameter must be used. It should be several inches in length, and should have the upper end opened out to a funnel shape, to facilitate the introduction of the powder. The tube being necessarily of large bore, the bottle must also be large, so that a small change of

* Proc. and Trans. N. S. Inst. Nat. Sci., Vol. VII. (1889), p. 368.

volume may be indicated by a comparatively large elevation or depression in the tube. The hydroxide should be in the form of a powder, not only that its solution may be accomplished quickly, but also because the solution formed must be dilute in order to secure a depression of the liquid in the tube. If it be not powdered, the substance falls to the bottom and forms a strong solution there, which only gradually diffuses into the water above. Even with a fine powder, however, a comparatively strong solution is formed at the bottom. Hence I have found it advisable to catch the powder in a wire gauze cage, attached by sealing-wax to the inner end of the rubber stopper which carries the tube, and to hasten the mixture of the strong solution, formed in the tube and cage, with the water, by diverting the downward currents of the strong solution towards the sides of the bottle by means of a plate of glass hanging horizontally below the cage. If a wide-mouthed bottle be used, a stirrer may be introduced through the stopper, but leakage is thereby rendered more probable. The full amount of the contraction indicated by Kohlrausch's observations cannot, of course, be shown. For (1), the powdered caustic soda already contains a considerable quantity of water; (2), the solution of the substance is attended by a development of heat involving a rise of the liquid in the tube; (3), the powder carries air with it into the water, which must increase the volume whether it dissolves or remains suspended; for in the latter case, if a quick effect is desired, there is not sufficient time for it to escape up the tube; and (4), whatever precautions may be taken to secure a uniform solution throughout the bottle, it cannot be at all completely secured in the time at disposal. But notwithstanding these difficulties, the experiment is a very striking one, especially if projected by a lantern on a screen. As the powdered caustic soda is passed down the tube, little by little, the liquid is seen to dissolve it without any increase in bulk, and if the substance does not already contain too much water, with an actual diminution in bulk, the level of the liquid sinking in the tube. If the powder be added in large quantity, there is a sudden rise of liquid in the tube, followed by a gradual shrinkage, which continues until the

level of the liquid is lower than at the outset. The amount of the depression of the liquid in the tube is sometimes small, depending apparently upon the amount of water which the powdered caustic soda has already absorbed. The substance should not be too finely powdered, as in that case it is likely both to have taken up a considerable quantity of water and to carry down with it a considerable quantity of air. The experiment requires only a few minutes to perform.

(2.) The working hypothesis which I use when thinking of the phenomena of solution, has led me to the conclusion that elevation of the temperature of a solution will have, if not identically, at any rate in a general way, the same effect on its selective absorption of light, and therefore on its colour, as increase in its concentration. All the experimental evidence of which I can find any record bears out this conclusion. But, whether it holds generally or not, it may be shown, by a striking lecture experiment, to hold in the case of two salts, the chlorides of cobalt ($CoCl_2$) and iron ($FeCl_6$). To do so, make a trough, for projection with a lantern, having thin glass sides, about the size of a lantern-slide, the glass sides being one or two mm. from one another. It may readily be made by cutting a U-shaped piece from a sheet of india rubber, and cementing the glass plates to its opposite sides. Half fill the trough with a saturated solution of either salt, and fill up with a weak solution. If cobalt chloride have been used, the solution in the lower part of the trough will at ordinary temperatures be of a purplish blue, that in the upper part red; and it will be obvious that increase of the concentration of this salt involves increase of blueness in the transmitted light. If, now, a Bunsen flame be played carefully over one side of the trough, the solutions rapidly rise in temperature, and both are seen to increase in blueness, the saturated solution becoming deep blue and the weak solution purplish red. If the iron chloride have been used, the solution in the lower part of the trough, before heating, is seen to be of a deep orange color, that in the upper part yellow; and it is obvious that increase in the concentration of this salt involves increase in redness. If, now, the

flame be applied as before, the yellow solution is at once seen to become orange and the orange solution red. Owing to the narrowness of the trough and the thinness of its glass sides, sufficient heating to produce a marked change of colour occupies only half a minute or so. The same trough may of course be used to project the absorption spectra of these solutions on the screen. If the slit be covered half by the one solution and half by the other, both absorption spectra may be seen at once, side by side, and the gradual variation of the spectra may be watched as the trough is gradually heated.

As a means of showing the variation of the colour or absorption spectrum of a solution with concentration, the above experiment has an obvious defect, viz., that the thickness of the layer of the strong and weak solutions being equal, the numbers of the salt molecules through which any ray of light passes are very different in the two cases. It should therefore be supplemented by showing also the colour or the spectrum obtained when the light is passed through a wide trough of the dilute solution, the ratio of the widths of the troughs being the reciprocal of the ratio of the percentages of salt in the two solutions.

(3.) Dr. W. W. J. Nicol's observation* that anhydrous sodium sulphate will dissolve in a supersaturated solution of that salt may readily be shown as a lecture experiment by projection. For that purpose place a test tube containing the solution, in a trough with glass sides full of water, and focus it on the screen. Then, let the anhydrous salt in the form of a fine powder, fall upon the surface of the solution. By taking a pinch of the powder between the thumb and forefinger (both being quite dry), it may be made to fall as a shower of fine particles. These pass into the solution and are seen to move slowly across the screen through the solution, dissolving as they go, in some cases disappearing, and often changing the concentration of the part of the solution through which they have passed, so as to produce obvious refraction effects. Finally, to show that the solution was supersaturated, add a few crystals of the hydrated salt and crystallization at once occurs. The anhydrous salt

* Phil. Mag., Ser. 5, Vol. xix (1885) p. 453.

must be added as a shower of fine powder, as larger pieces may by taking up water and forming crystals of the hydrated salt before they can dissolve, give rise to a general crystallization of the solution.

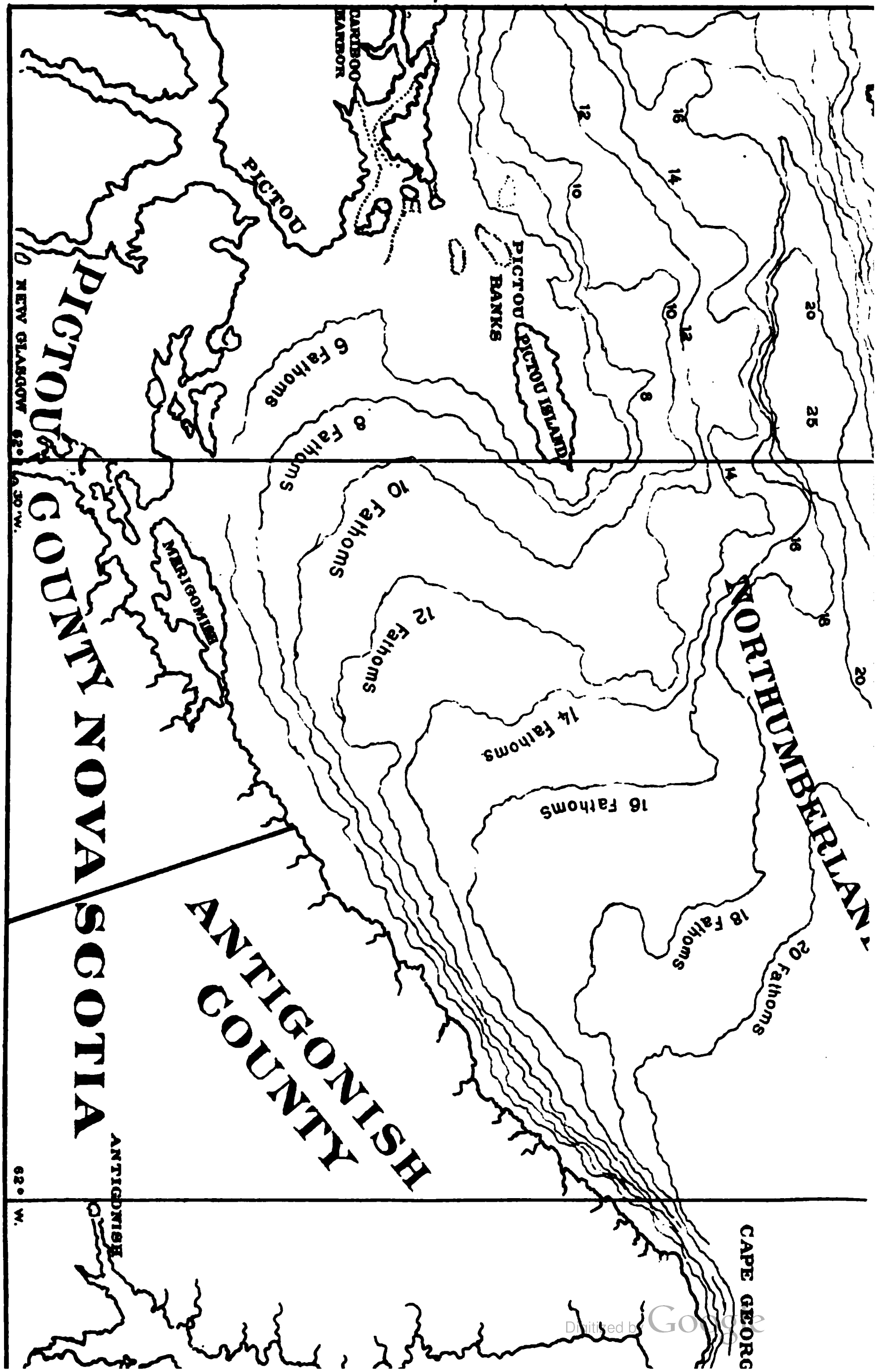
(4.) The peculiarity of the solubility in water of such substances as anilin, carbolic acid, etc., observed by Alexejew,* may readily be shown on the screen, by using carbolic acid, whose critical temperature (the temperature above which it and water are mutually infinitely soluble) is about 69° C. For this purpose, pour some of the acid into a long test-tube, of about 12 or 15 mm. diameter, and add water. The water will lie in a layer above the acid. Support the test-tube by a clip grasping it at the top, and focus on the screen. The line of demarcation between the two liquids will be evident. Now mix the liquids by stirring, and the whole becomes cloudy. Let the tube stand, and the liquid separates again into two layers, having different depths from those they had before, both being now solutions. As this process requires considerable time, the stirring may have been done beforehand. Next surround the test-tube by a beaker of boiling water, passing it upwards from below, and stir the liquids with a hot glass rod. A slight cloudiness appears, but the liquid quickly clears and is seen to have become homogenous throughout, the line of demarcation having disappeared. If now the beaker of hot water be removed, and one of cold water be substituted for it, the liquid becomes cloudy, a strong solution separating out everywhere, and the little spherical masses of strong solution sinking and coalescing as they sink, to form larger spheres. After a time the liquid is seen to have again become separated into two layers. If the necessary time is not available, the separation into layers may be obtained very quickly by removing the beaker of cold water and again applying the hot bath, which, raising the temperature, stops the separating out of the strong solution and re-dissolves it in the surrounding weaker solution, thus producing a comparatively strong solution in the lower part of the tube and a comparatively weak one in the upper part. The experiment requires but a few minutes and is both striking and instructive.

* Wied. Ann. Bd. XXVIII. (1886), p. 305.

VIII. — PICTOU ISLAND. — BY A. H. MACKAY, B. A., B. SC., F. R. S. C.

Pictou Island lies in the Straits of Northumberland, mid-way between Pictou County, Nova Scotia, and Prince Edward Island, between lat. N. 45° 48′ and 45° 50′ and lon. W. 62° 30′ and 62° 35′. It is about five miles long and one wide, the axis of its greatest length being nearly due magnetic east and west, *i. e.*, astronomically about N. 65° E. A circle described from the centre of the island with a radius of about eleven miles would touch the approximately parallel coast of Prince Edward Island on the one side and come within a mile of the nearly parallel island of Merigomish and adjacent coast line on the other side, while it would reach the land near the mouth of Pictou Harbor, cutting off the head of the peninsula on which the town is built, leaving the mainland tangential to the coast line of Carriboo Harbor. The island rises from 100 feet in the west to 150 feet in its eastern half above the level of the sea; and its rock base exposed by the action of the water around the coast line, is capped to the depth of many feet with boulder clay and gravel drift forming a gently undulating surface and a superior soil for all agricultural purposes. Seven or eight miles towards Prince Edward Island, the water attains a depth equal to the island's extreme height, and on the other side towards Merigomish it attains a depth of only one half, about 75 feet.

From a glance at the map it will be observed that the corrugations of the earth surface running northeasterly and southwesterly are well marked in Nova Scotia and New Brunswick. The general elevation of Nova Scotia above the water is in this direction, as is also the coast line, the mountains, and the depressions of the Bras d'Or in Cape Breton, the coast line of Nova Scotia from near Pictou Harbor to Cape George, the synclinal depression of Pictou Harbor itself, which appears to run out in the strait parallel to the coast, the depression of the Hillsborough River in Prince Edward Island, and portions of


CARIBOO HARBOR
PICTOU
PICTOU BANKS
PICTOU ISLAND
PICTOU COUNTY
NEW GLASGOW
62° 30' W.
MERIGOMISH
NOVA SCOTIA
ANTIGONISH COUNTY
ANTIGONISH
62° W.
NORTHUMBERLAN
CAPE GEORG
6 Fathoms
8 Fathoms
10 Fathoms
12 Fathoms
14 fathoms
16 Fathoms
18 Fathoms
20 Fathoms

the coast line such as that from Cardigan Bay to East Point. Pictou Island would thus appear to be the highest part of the crest of a submarine ridge of elevation of the bottom of the strait, which may be traced from the mainland through the islands outside Carriboo Harbor and a series of shoals in some places reaching to within 10 or 12 feet of the surface of the water for a distance of eleven miles to Pictou Island, then for five miles in the island itself, then for about 20 miles more northeasterly until it passes beyond a line from Cape George to Cape Bear. This elevation in the floor of the strait may be compared to a huge submarine monster whose head is the islands abutting against the mainland at Carriboo Harbor, whose neck and shoulders are the six or seven miles of shoals and banks extending to the Pictou Island, whose humped or crested back is the five miles of the island itself, and whose submerged tail extends in the same general direction, N. 60° E., midway between and subparallel to the coast line on each side, until it vanishes in the wide bay beyond the capes about forty miles from its head.

The floor of the strait and the land on each side appear to rest on Upper Carboniferous or Permian rocks. The base of this group is considered to be the belt of New Glasgow conglomerate lying immediately above the coal measures. This conglomerate belt is also sub-parallel to the coast line. From Merigomish to New Glasgow it lies about N. 70° E., while the coast line easterly is about 60°. West of New Glasgow the conglomerate gradually curves to 80° and ultimately runs nearly east and west, tending to become sub-parallel to the sharp flexure of the coast line in the vicinity of Pictou Harbor.

Pictou Harbor is a narrow depression in the sandstone rocks newer than the conglomerate, caused by a downward folding as much below the general surface of the country as the deepest channel of the straits is below the coast line. The axis of this synclinal depression runs about N. 60° E. parallel to and between the Merigomish and Antigonish coast line on the one side and the Pictou Island sub-marine ridge on the other side; which suggests that this half of the bottom of the strait is floored with the sandstones on each side of Pictou Harbor, and that the sharp flexure

of the coast line between Merigomish and Cariboo was caused by the more complete collapse of the Pictou synclinal just at the harbor's mouth, which submerged the Permian entirely between Merigomish and Pictou Island.

We now come to examine the structure of our submarine ridge as shown by its exposure in Pictou Island. The rocks are well exposed nearly all round, and they dip down on each side into the Nova Scotia and Prince Edward Island troughs of the strait. The anticlinal axis is well marked, running from one extremity nearly to the other, not exactly in the direction of the greatest length of the island and the submarine ridge but approximately so, N. 84° E. This line when produced would appear to pass a little north of Carriboo Islands and strike a distant anticlinal in the Permian rocks at Cape John. However, from the observations of Sir Wm. Dawson (Acadian Geology, 1868, page 327), and from the variable dips, and possible faults in the region, the anticlinal west of Pictou Harbor probably occurs at the mouth of the Cariboo River, from which we would infer that the Pictou Island submarine ridge is on an anticlinal axis sub-parallel to the Pictou Harbor synclinal axis and to the present coast line of East Pictou and Antigonish.

Before giving the detailed measurements of the different strata of the island (for which I am entirely indebted to Hugh Fletcher, Esq., B. A., of the Geological Survey of Canada, with whom I had the great pleasure, in August, 1890, of studying the geological structure of the island), it may be well to give a general description. As has been already indicated, every part of the island has superior soil for agricultural purposes, and excellent springs of water. Crops appear to be more luxuriant than on the mainland. One main road runs through the length of island. It contains some thirty families, specially healthy and comfortable, of Scottish descent, with a good school. During the summer, lobster fishing and canning draw some more inhabitants to the community. A lighthouse is situated at the southeastern point of the island, from which point we number our geological sections of the coast.

Coarse sandstone strata of different textures abound, some of

which would make good grindstone. Fossil plants and stems and trunks of trees imperfectly preserved are observable at several points, and are often strongly impregnated with iron pyrite. No indications of copper were seen, although such are very common in the Permian rocks of the mainland. Strata of limestone probably run under the island. It is exposed towards the west end of the south coast and again apparently on the north side of West Point. Its probable outcrop will be under the drift parallel to the anticlinal axis and near the northeast coast, its eastern outcrop being probably contained in the concealed measures immediately south of Seal Point. Westerly it probably curves parallel to the west coast to its exposure on the south. The course of the anticlinal from near Light House Point to north of West Point is as has been mentioned about 84°. The westerly dip of the rocks at the commencement seem to indicate that its axis is slightly tilted. The sections begin at Light House Point and follow the shore northward, then west and south and east to point of beginning. They are of course only approximate, the dip being too changeable, particularly in the sandstone, to admit of close measurement. A thickness of only 562 feet of strata occupies the whole shore.

SECTIONS ON THE SHORE OF PICTOU ISLAND.

Section I.

From Lighthouse Point, westward, in ascending order.

	Ft.	In.
1. Gray sandstone of Lighthouse Point, in thick and shaly beds; with carbonized plants and spheroidal concretions; false bedding. The upper part is fine. Certain bands have been quarried, but the want of a shipping-place has retarded the development of this industry. Dip 24° $\angle$ 3° (astronomical, the variation being about 24° W.). Cliffs 15 feet high. Of indefinite thickness; exposed on both sides of the anticline for a great distance	173	0

	Ft.	In.
2. Red marl and sandstone, with harder greenish bands. The marl contains nodules of impure concretionary limestone, also green spots, stripes and blotches. Dip 14° < 4°	91	0
3. Measures concealed by a sandy cove to wharf at the lobster factory	77	0
4. Measures concealed from wharf. Dip 3° < 3°....	39	0
5. Greenish-gray and light gray sandstone, like that of Merigomish, of good grindstone grit, in thick jointed beds................................	29	0
6. Gray sandstone, like 2, but full of hard spots or bull's-eyes	16	0
7. Gray sandstone, with pyrites and calcspar. Markings of *Lepidodendra* and of other plants. Dip 336° < 7°. Seal Point	85	0
8. Measure concealed on a sandy shore at a small brook. Dip 1° < 5°	7	0
9. Reddish-gray fine sandstone, in thick beds, exposed on low reefs, alternating with greenish-gray and gray coarse and fine sandstone, with carbonized drift-plants. A band of light gray sandstone of good grindstone grit at top. Not well seen, but for a great distance on strike in reefs.........	45	0
	562	0

Ascending as far as McLean's Point, then descending to repeat the foregoing measures as follows.

Section II.

At McLean's Point, descending.

	Ft.	In.
1. Gray sandstone like that of Chance Harbor and the vicinity..............	155	0
2. Measures concealed in cove at lobster factory on the north side,—a white sandy cove into which flows two little brooks......................	75	0
Section now ascends.	230	0

SECTION III.

Rocks from Lobster Factory Cove, westward, in ascending order.

No.	Description	Ft.	In.
1.	Measures concealed. Dip 316° ∠ 4°	21	0
2.	Reddish and gray, shaly and thick bedded sandstones, exposures of which begin 40 yards north of a fish-house at the mouth of a brook	15	0
3.	Brownish and gray sandstone in thick beds fit for grindstones. Dip 0° ∠ 7°	13	0
4.	Greenish and reddish nodular, concretionary, calcareous marl		
5.	Gray, fine, flaggy sandstone	15	0
6.	Light-gray, rusty-weathering, coarse, pebbly, crumbly sandstone like that of Toney River. Dip 311° ∠ 3°	10	0
7.	Gray, fine, crumbly sandstone	12	0
8.	Gray, rusty-weathering, pebbly sandstone to a spring which deposits yellow ochre	35	0
9.	Gray sandstone in unbroken reefs	17	0
*10.	Measures concealed, but probably reddish or brownish sandstone seen at intervals in reefs immediately east of a little pond or marsh	14	0
*11.	Measures concealed by a fishing cove, Dip 292° ∠ 4°. Very many blocks indicate that blueish-gray limestone is in place in this interval	46	0
†12.	Light-gray, pebbly, concretionary, calcareous rock		
†13.	Gray and brownish, flaggy, fine sandstone well exposed in reefs	56	0
†14.	Reddish-gray sandstone and shale with bands of gray, fine sandstone; not well exposed. Dip 273° ∠ 5.°	43	0
†15.	Red and green concretionary marl		
†16.	Gray, fine sandstone exposed on west point with a dip which bends sharply to 182° ∠ 8	87	0
†17.	Light-gray, crumbly, coarse, thick bedded, pebbly		

*Perhaps underlying the thick sandstone.

†Perhaps Nos. 1 to 9 repeated and nearly doubled by being measured at the turn of the anticlinal.

	Ft.	In.
sandstone seen east of the point. The highest rocks are on reefs about 400 yards west of a wharf and lobster factory near Hugh McLean's. Dip. 182° ∢ 14°	53	0
	437	0

The section is now repeated descending.

Section IV.

From near West Point, eastward, in descending order.

		Ft.	In.
1.	Gray sandstone, Nos. 14 and 15 above. Dip. 182° ∢ 14°	140	0
2.	Light-gray, pebbly, concretionary, calcareous rock	–	–
3.	Red marl	2	6
4.	Bluish-gray, knobby, impure limestone	2	0
5.	Red marl and sandstone. Dip 182° ∢ 17°	48	0
6.	Gray, rusty-weathering, fine sandstone in flaggy beds	36	0
7.	Red sandstone and marl. Dip 187° ∢ 18°	9	0
8.	Gray limestone of fair quality, like that of Cariboo and Cape John	1	6
9.	Red marl	8	0
10.	Gray limestone	1	0
11.	Red, shaly sandstone and marl with dark red blotches and green spots. Here, near a brook, begins a beach and low bank of brownish-white fine sand, which occupies the south shore of the island for more than a mile. The relation of the rocks next seen to eastward is consequently obscure, but as the dip of the succeeding rocks is similar, we may perhaps assume that they directly underlie the red strata	46	0
12.	Gray sandstone, coarse and pebbly or fine and flaggy, alternating with bands of red marl and sandstone with nodules of limestone. Dip 164° ∢ 13°. Extends 45 chains to eastward of the		

	Ft.	In.
public wharf, the shore conforming with the dip which turns more to westward, and the cliffs being of the following:		
13. Gray fine sandstone and coarse rusty-weathering sandstone, in thick and in flaggy beds full of broken plant remains and of prostrate and erect trees mineralized with calcspar and siderite. Dip 188° ∢ 10°. Quarried for grindstones some years ago near the wharf....................	91	0
14. Gray thick-bedded sandstone, full of plant remains and of aggregations of "bulls-eyes." Dip. 232° ∢ 10° to 263° ∢ 4°, then turning northeasterly and repeating the rocks in ascending order from Light House Point........................	82	0
	467	0

VIII.—Notes for a Flora of Nova Scotia. Part I*.—By George Lawson, Ph. D., LL. D.

[*Received July 15th, 1891.*]

RANUNCULACEÆ.†

Clematis Virginiana, *Linn.* Banks of streams, rocky or stony banks, ravines, etc., climbing over bushes and small trees. Shores of Bras d'Or Lake, between Whycocomagh and West Bay, Cape Breton. Banks of the Sackville River; abundant near the iron bridge, and at several spots along the Windsor Road between Bedford and Salmon Hole, Halifax County.

Wilmot, Ann., near New Glasgow, Pictou County, and Falmouth, Hants, Dr. How. Pictou, A. H. McKay and Dr. Lindsay. Whycocomagh, Dr. Lindsay. Truro, banks of streams, among alders, etc., common, Dr. G. C. Campbell. This plant has been cultivated in England since 1767, as an ornamental creeper, being well adapted for covering walls and arbours; its flowers are highly fragrant, which is unusual in the genus, and the wreaths of feathery plumes formed by the fruiting plant in autumn are very striking. In Nova Scotia it succeeds best on the shady sides of buildings.

This species is figured in Mrs. Miller's series of life-sized coloured drawings of the wild flowers of Nova Scotia, Part V.,

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* Let not these *Notes* be regarded as, in any sense, a *Flora* of Nova Scotia. Our Flora is a very rich one, especially in northern species and forms, and a more careful comparison of our plants with those of Newfoundland, the Greenland shores, Iceland, Great Britain, Scandinavia, and the Russian Empire, may be expected to yield results of more than local interest. The present Notes, then, even when completed by extension to the remaining Orders, must be looked upon as representing a mere fragment of our Flora, showing only its more obvious features. My object has been to bring together, in a convenient form, as much as possible of what is now known, so as to present a prodromal list that may be useful to those willing to aid in exploration. Large collections of Nova Scotia specimens that have already been made are still unexamined, and much remains to be done by collectors in the supply of additional material before even an approximately full list of our plants can be prepared. Corrections and additions will be thankfully received.

† For full descriptions of the several species, and their synonymy, see Lawson's Monograph of Canadian Ranunculaceæ, in Transactions of the Nova Scotia Institute, Vol. II., Part IV., pages 18-51 (1870); also, Revision of the Canadian Ranunculaceæ, in Transactions of the Royal Society of Canada, Vol. II., Sec. IV, pp. 15-90 (1884).

tab. 14; letterpress description by Dr. Lawson. Published by Reeves, London.

THALICTRUM CORNUTII. Tall Meadow Rue. False Maiden-Hair. Dr. Cornuti's Thalietrum. *Thalietrum Canadense*, Cornutii Canadensium Plantarum Historia, caput LXX., p. 186, (Paris, 1635). The letterpress description may pass for our plant, but the engraving is that of a different species. The spelling Thali*e*trum runs all through the Historia of Cornutius, and is carefully reproduced by Tournefort (Inst. Rei Herb.). Wet meadows and margins of streams and permanent brooks. On elevated banks of streams, where the roots cannot reach the water or moist soil, the plant becomes very much dwarfed, but loses none of its distinctive characters. Not uncommon in many parts of Nova Scotia; abundant along the Sackville River and ditches of the Rifle Range, Bedford, and neighborhood, County of Halifax.

Digby Gut, County of Digby (7 feet high); Windsor Falls and Windsor (8 feet), and Windsor, Hants County, Dr. How. Truro, marshes, common, Dr. G. C. Campbell. Strait of Canso, Guysborough County, Rev. E. H. Ball. Ellershouse, Hants County, Mr. Beckman. Pictou, A. H. McKay. A form (5 or 6 feet high) with all the parts of the flower of a deep purple colour, but differing in no other respect, occurs in a wet pasture by the roadside on the Old Windsor Road, thirteen miles from the city of Halifax.

T. Cornutii is a very distinct species, and the only one of the genus actually known to exist in Nova Scotia; but, in the descriptions and figures in books, as well as in specimens in Herbaria in different countries, it has been very much mixed with other species. The name *Cornutii*, hitherto misspelt by *all* botanists, *Cornuti*, has thus become complex and enigmatical. To remedy this, Mr. Watson, in the sixth edition of Gray's Manual, has adopted the name *polygamum*, which, however, is open to the same objection. Lecoyer adopts DeCandolle's name, *corynellum*. Freyn, of Prague, the latest writer on Ranunculaceæ, favours retaining *Cornutii* for our plant. The Abbe Provancher prefers the old pre-Linnæan name,

Canadense, given by Cornutius. In these circumstances, I have, meantime, kept the name to which we have been accustomed, and hope to deal with the question of nomenclature at an early opportunity. In Part III. of Macoun's Catalogue of Canadian Plants, p. 479, Bedford, Nova Scotia, is cited as a station for *Thalictrum purpurascens*, Linn. On representing to Prof. Macoun the unlikelihood of that plant existing there, without having been detected by myself or some local botanist, he made investigation, and now authorizes me to state that the record referred to is an error that had crept in from some old notes made before the true character of *purpurascens* was understood. It appears that the Bedford specimens of *Thalictrum* have always stood in the Ottawa Herbarium labelled as *T. Cornutii*, as they ought to be.*

ANEMONE HEPATICA, *Linn.* Grows usually in hard-wood lands; rare in Nova Scotia.

Nesbit's Island, and Falmouth, near Windsor, Hants, rare, Dr. How. Bridgewater, Lunenburg County, Rev. E. H. Ball. Pictou, very rare, A. H. Mackay.

This is the *Hepatica triloba* of Gray's Manual, but should not be separated as a genus from *Anemone.*

ANEMONE NEMOROSA, *Linn.* Wood Anemone. Anemone, or Wind-Flower, of the English poets. In woods, rare in Nova Scotia.

River bank at Middle Stewiacke, Colchester, May 27th, 1884, Dr. G. C. Campbell. Newport, Hants, H. H. Bell.

ANEMONE VIRGINIANA, *Linn.* Usually grows on intervales along the banks of rivers, but rare in Nova Scotia.

Truro, Salmon River bank, Dr. G. C. Campbell.

ANEMONE DICHOTOMA, *Linn.* Rare in Nova Scotia.

Near Truro, Colchester County, Dr. D. A. Campbell. *A. dichotoma* is the prior name of the species (dating from the year of the settlement of Halifax, 1749), but, in Gray's Manual, and in Lindsay and Somers' List, it will be found under the later specific name, *Pennsylvanica.*

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* For ample details of synonymy of the genus, see "Monographie du genre *Thalictrum*, par J. C. Lecoyer. Gand: imprimerie C. Annoot-Braeckman, 1885. Pp. 249. Tab. V,

RANUNCULUS AQUATILIS, var. LONGIROSTRIS, *Lawson*. White Water Crowfoot. In ponds and slow streams, rare.

Near Truro, Colchester County, Dr. D. A. Campbell. Ditches in Little Marsh, Truro, near Smith's Island, 11th June, 1884, Dr. G. C. Campbell. Of *R. aquatilis*, many varieties, or species, have been described in Europe, from careful study of the living plants. The American forms are still imperfectly known, and descriptions have been made, in many cases, from dried specimens. Our plant differs from the European *trichophyllus* (the name used in Gray's Manual) in the brighter but paler green colour of its leaves (not blackish or inky), in the carpels having prominent beaks, and in their being not merely rounded but inflated on the peripheral side.

RANUNCULUS MULTIFIDUS, *Pursh*. Yellow Water Crowfoot. In ditches and shallow muddy pools, rare.

Windsor, Hants Co., and near Sydney Bar, Cape Breton, Dr. How. Truro, in water, in ditches and marshes, common. June, 1883, Dr. G. C. Campbell.

RANUNCULUS REPTANS, *Linn*. Creeping Spearwort. Gravelly banks of lakes and rivers.

Dartmouth. Truro, in fields, low grounds, etc., common, Dr. G. C. Campbell.

RANUNCULUS CYMBALARIA, *Pursh*. Seashore Crowfoot. Head of Bedford Basin, Halifax Co., on the shore between Bedford Hotel and the high Railway Bridge.

Musquodoboit River, Halifax County, 26th June, 1878, Dr. Lindsay. Avon River, Falmouth, Hants, Dr. How. Sable Island, Lindsay & Somers' List. Glace Bay, Cape Breton, H. Poole.

This is especially a coast plant, growing not only along our shores but generally on the northern coasts of America, the Gulf of St. Lawrence, Anticosti, and Hudson Bay to near the Arctic Sea. It has also been found at Lake Superior, Lake Winnipeg, at salt ponds in the prairie, on the Rocky Mountains, and on the Pacific Coast.

RANUNCULUS ABORTIVUS, *Linn*. In pastures and clearings;

doubtful if indigenous in Nova Scotia. Lucyfield, sparingly spontaneous.

Pictou, A. H. Mackay. Near Truro, Dr. D. A. Campbell. Truro, cultivated fields, common, Dr. G. C. Campbell.

RANUNCULUS ACRIS, *Linn.* A European plant, now common in hay-fields and by roadsides in many parts of Nova Scotia, as on the Halifax peninsula, about Truro and other places in Colchester, Caledonia, Queen's County, etc. Animals reject this species, but greedily eat the herbage of *R. repens*.

Windsor, Hants, Dr. How. Pictou, A. H. Mackay. Port Mulgrave, Rev. E. H. Ball. Truro, very abundant in grass on roadsides, etc., Dr. G. C. Campbell.

RANUNCULUS REPENS, *Linn.* In fields and wet pastures, etc., abundant; a weed in gardens. A small, depressed, smooth-leaved form, with flowers no larger than those of *acris* and sometimes smaller, occurs on the sea-shore around Bedford Basin.

Windsor, Dr. How. Truro, in fields, low grounds, etc., common, Dr. G. C. Campbell. Pictou, A. H. Mackay. Port Mulgrave, Rev. E. H. Ball.

R. septentrionalis, Poiret, credited by Macoun to Whycocomagh, Cape Breton, was in former editions of Gray's Manual, included under *R. repens*. It is now treated as a separate species, being distinguished apparently by the following characters:

R. repens: style subulate, stigmatose along the inner margin, mostly persistent.

R. septentrionalis: style long and attenuate, stigmatose at the tip, persistent, or the upper part usually deciduous.

In Coulter's Manual of the Western Texas Flora (1891), the differences are expressed thus:

R. repens: style short-subulate, stigmatic the whole length, mostly persistent.

R. septentrionalis: style long and attenuate, stigmatic at the tip, persistent, or the upper part deciduous.

So far as observed, none of the specimens of so-called *repens*, collected in Nova Scotia, respond to the character required by *septentrionalis*.

RANUNCULUS PENNSYLVANICUS, *Linn. fil.*
Pictou, A. H. Mackay.

RANUNCULUS RECURVATUS, *Poiret.*
Pictou, A. H. Mackay.

RANUNCULUS BULBOSUS, *Linn.* This old-world plant, which grows abundantly as an indigenous species in middle and southern Europe and parts of North Africa and in Asia, was found, at an early period, to have become naturalized inseveral parts of North America. It is one of the few (5) species of *Ranunculus* described in Michaux's Flora Boreali-Americana, (1803), its location being moist meadows in Pennsylvania.

It was gathered in Canada by the Marchioness Dalhousie. Morrison collected it in Newfoundland, as noted by Hooker. More recently it was found in Point Pleasant Park, Halifax, Nova Scotia, (July, 1884), perfectly naturalized, by Rev. Robert Laing. It has also been observed near Shelburne, in the western part of the Province, by Rev. Mr. Rossborough. Linnæus retained for this plant the characteristic name given to it by Thalius in 1588, and it has no synonyms.

CALTHA PALUSTRIS, *Linn.* Marsh Marigold. In slow streams and pools; not common in Nova Scotia, as it is in the West. I have seen specimens in the Herbarium of the Geological Survey at Ottawa, collected by Prof. Macoun at Whycocomagh, Cape Breton, July 22nd, 1883.

Mahone Bay, Lunenburg County, Rev. E. H. Ball.

COPTIS TRIFOLIA, *Salisbury.* Gold Thread. It wet places in woods, probably general throughout the whole of Nova Scotia and Cape Breton; but localities should be noted. Between Beaver Bank Station and Windsor Road, common; North-west Arm, Dutch Village, Dartmouth, Caledonia, etc.

Windsor, Hants, Dr. How. Pictou, A. H. Mackay. Manchester, Guysborough County, Rev. E. H. Ball. Truro, in spruce woods, etc., common, Dr. G. C. Campbell.

According to Hortus Kewensis, this plant was introduced to English Gardens by the Hudson Bay Company in 1782. Under

the name of Gold Thread, which it has obtained on account of the rich yellow colour of its root fibres, this herb is commonly sold for medicinal purposes in our markets. Large quantities are exported from Yarmouth to the druggists of the United States.

AQUILEGIA VULGARIS, *Linn.* English Columbine. A European plant that has spread from gardens and established itself as a colonist in several localities in Nova Scotia. It is especially abundant and beautiful, presenting many variations in the colour of its blossoms, in the deep rock-cutting of the railway at "the Prince's Lodge," the former residence of the Duke of Kent, on the west shore of Bedford Basin, near Halifax. Old Windsor Road, abundant in several places.

Pictou, A. H. Mackay.

ACONITUM NAPELLUS. Wolf's Bane. Aconite. Found occasionally as a garden ontcast, not inclined to spread, but very persistent where once grown. Lucyfield, Middle Sackville, Halifax County. Bank overhanging Lockman Street, Halifax, on the west side, a short distance south of North Street.

The original name, *A. Napellus*, as used by Linnæus, seems to have included at least two European and one American species.

ACTÆA ALBA, *Bigelow.* Blomidon, King's County, 1882.

Windsor Falls; Butler's Mountain: Nesbit's Island, and in Hants Connty, Dr. How, in "Notes." Pictou, A. H. Mackay. Strait of Canso, Guysborough County, Rev. E. H. Ball. Truro, Colchester, Dr. D. A. Campbell.

ACTÆA RUBRA, *Willdenow.* Blomidon, King's County, and Lucyfield, Halifax County.

Windsor, Hants County, Dr. How. Pictou, A. H. Mackay. Strait of Canso, Guysborough, Rev. E. H. Ball. Truro, Dr. D. A. Campbell. Glace Bay, Cape Breton, H. Poole. Truro, in hard wood, at the Falls; also, banks of ravine, back of Terrace Hill Cemetery; East Mountain, Onslow, Colchester; banks of Salmon River, Colchester, with white berries and more *slender* pedicles, Dr. G. C. Campbell.

MAGNOLIACEÆ.

MAGNOLIA ACUMINATA, *Linn.* Magnolia. Cucumber Tree. Planted trees of this species grow well in the Public Gardens, Halifax, and at Bellahill, Sackville (in front of the house); but in Nova Scotia we have no indigenous species of this order, which in pre-glacial times was spread over the northern parts of North America, extending even within the Arctic circle.

LIRIODENDRON TULIPIFERA, *Linn.* Known only as a planted ornamental tree. Waverley House, Canning, King's Co. Public Gardens, Halifax. Mr. G. A. Thompson, of Massachusetts, after visiting Nova Scotia in 1873, wrote to the late Dr. How: "I was quite surprised to see the *Liriodendron Tulipifera* successfully cultivated so far north. I had seen only one or two specimens in Massachusetts."

BERBERIDACEÆ.

BERBERIS VULGARIS, *Linn.* Common Barberry. Windsor, Hants County, cultivated, Dr. How. Lucyfield, Halifax County. Ornamental grounds about the city of Halifax, Public Gardens, etc. A European shrub, not native here, but occurs as an occasional remnant of cultivation. (The allied *Berberis Canadensis*, so called, belongs to the Southern States, and was never found in Canada.)

PODOPHYLLUM PELTATUM, *Linn.* Not indigenous in Nova Scotia, although abundant in Ontario. Lucyfield, and old gardens about Halifax, the Public Gardens, etc.

NYMPHÆACEÆ.*

NYMPHÆA ADVENA, *Aiton.* American Yellow Pond Lily. In ponds and pools, shallows along lake margins, and along river courses, common. Halifax County, abundant.

Caledonia, Queen's County; Hants, and Cape Breton, Dr. How.

*For details in regard to Nomenclature and Synonymy of NYMPHÆACEÆ, see the Author's paper in Transactions of the Royal Society of Canada, Vol. VIII, Sec. IV, pp 97-125, 1888.

Pictou, A. H. Mackay. At Truro, in brooks and gullies in the Marsh, common, Dr. G. C. Campbell.

NYMPHÆA MICROPHYLLA, *Persoon*. Alton and Johnson's Crossing, I. C. R.

NYMPHÆA LUTEA, *Linn*. English Yellow Pond Lily. It is stated that "specimens referred to this species were gathered in Black Brook, near Albert Bridge, between South Sydney and Louisburg, Cape Breton."—Macoun's Catalogue, Part III, p. 484. It is very desirable that a careful examination of the plant in that locality should be made.

CASTALIA ODORATA, *Greene*. *Nymphæa odorata*, Aiton, and of Gray's Manual. White Water Lily. Scented Water Lily. Abundant in the Dartmouth Lakes, Lily Lake, Rocky Lake, and the lakes generally of Halifax County, and of many other parts of Nova Scotia.

Pictou, A. H. Mackay. In Lily Pond, near Truro Cemetery, Dr. G. C. Campbell.

The variety *minor*, with very small leaves and flowers, should be looked for. *C. tuberosa*, with leaves green on both sides (as in the English *C. alba*), is a western and southern species, so far as at present known.

BRASENIA PELTATA. *Pursh*. Water Shield. In shallows and pools around the lake shores. Rocky Lake and the connected and neighbouring lakes in Halifax County, abundant; probably not uncommon throughout the Province, most parts of which are furnished with lakes. Few special localities have been noted.

Big Liscomb Lake, Guysborough County, E. R. Faribault, (Macoun's Cat.)

SARRACENIACEÆ.

SARRACENIA PURPUREA, *Linn*. Side-Saddle Flower. Pitcher Plant. Deer Cups. Lawrencetown swamps, Lily Lake, Point Pleasant Park, and many other places in Halifax County, Mount Uniacke lakes and swamps. On the summit of the

mountain range on the north side of Great Bras d'Or, Cape Breton.

Peat bogs at Cow Bay, C. B., Dr. G. C. Campbell. Near Windsor, Hants, Dr. How. Pictou, A. H. Mackay. Mahone Bay, Lunenburg County, Rev. E. H. Ball.

PAPAVERACEÆ.

SANGUINARIA CANADENSIS, *Linn.* Canadian Blood Root. Pictou, A. H. Mackay. Near Truro, Colchester, Dr. D. A. Campbell. Lucyfield, Halifax County, introduced. (*Chelidonium majus* has been doubtfully recorded as an Annapolis plant.)

PAPAVER SOMNIFERUM, *Linn.* Opium Poppy. An occasional and rather persistent escape from cultivation; still retains its hold around very old homesteads. Lucyfield, Halifax County. Windsor, Hants, introduced, Dr. How.

PAPAVER RHŒAS, *Linn.* On waste heaps, North Sydney, Cape Breton, Macoun's Cat., p. 484, This, and other European species of the genus, are apt to occur in fields sown with grain from Europe where they are common field weeds.

FUMARIACEÆ,

ADLUMIA CIRRHOSA, *Rafinesque.* Not indigenous, so far as known, in Nova Scotia, but spontaneous in gardens and grounds. It is a biennial plant, growing from seed the first year; flowering during the second season, when it produces seeds and dies. When once introduced it is very persistent, the seeds retaining vitality in the soil for many years.

DICENTRA CUCULLARIA, *DC.* Dutchman's Breeches. Pictou, A. H. Mackay. The Falls, Truro, and Debert Mills, Colchester County, Dr. G. C. Campbell.

DICENTRA CANADENSIS, *DC.* Squirrel Corn. Near Truro, Dr. D. A. Campbell and Dr. Lindsay, in Catalogue.

CORYDALIS GLAUCA, *Pursh.* In rocky places, especially where vegetable mould has washed into hollows or pockets. Is apt to

appear during the first year on newly burnt land, from seeds that have lain dormant, and to disappear as suddenly, giving way to stronger herbage. On rocky ridges extending from Windsor Junction to Sackville River. Beaver Bank Road, in burnt land, 1860, not permanent there.

St. Croix and Windsor, Hants, Dr. How. North-West Arm, Halifax, Drs. Somers and Lindsay. Truro, newly cleared land, near Terrace Cemetery, Dr. G. C, Campbell.

FUMARIA OFFICINALIS, *Linn.* Fumitory. Sparingly spontaneous in gardens in Halifax; a European weed.

FUMARIA PARVIFLORA, *Lamarck.* On waste heaps at Bedford, Pictou, and North Sydney, Macoun's Catalogue.

CRUCIFERÆ.

DENTARIA DIPHYLLA, *Linn.* In woods. Pictou, A. H. Mackay. Truro, in ravine back of Terrace Hill Cemetery, Dr. G. C. Campbell.

CARDAMINE RHOMBOIDEA, *DC.* Pictou, A. H. Mackay. Near Truro, Drs. D. A. Campbell and Lindsay.

CARDAMINE HIRSUTA, *Linn.* Near Windsor, Dr. How. Pictou, A. H. Mackay.

CAMELINA SATIVA, *Crantz.* In grain fields, introduced with foreign seed, but not permanent.

NASTURTIUM OFFICINALE, *R. Br.* Water Cress. Plentiful in two brooks near the Three Mile Plains, between Windsor (town) and Newport; buckets of it were brought to an English colleague and myself, both of us being glad to renew our acquaintance with onr pungent favourite of former days, Dr. How, "Notes." Truro, Dr. D. A. Campbell. Truro, brooks and ditches, common, Dr. G. C. Campbell.

It is desirable to ascertain whether this is really an indigenous species in Nova Scotia, or has been introduced artifically. In some parts of Ontario Province, as in brooks running into the St. Lawrence River, between Kingston and Brockville, there is a

form which certainly looks like a true native plant, and there appears to be no doubt of its being indigenous on the north-west coast, while it has been regarded by some as also indigenous in the Southern States; but in Gray's Manual it is treated, as regards the Northern States, simply as an escape from cultivation.

NASTURTIUM ARMORACIA, *Fries*. Horse Radish. Rubbish heaps about Halifax city and other towns and villages, a garden outcast.

NASTURTIUM PALUSTRE, *DC*. On ballast heaps at Pictou, and at North Sydney, Cape Breton, apparently introduced, Macoun's Catalogue.

BARBAREA VULGARIS, *R. Br*. St. Barbara's Herb. Formerly abundant about Four Mile House (about Hotel St. Elmo), the village now known as Rockingham, on the western shore of Bedford Basin. Pictou, A. H. Mackay.

This plant is regarded as truly, indigenons in the region to the north and west of Lake Superior; whether it is so in Nova Scotia is doubtful.

HESPERIS MATRONALIS, *Linn*. Dame's Violet. Grows in old gardens, and persistent. Pulsifer's and Lucyfield, Sackville, Halifax County.

SISYMBRIUM OFFICINALE, *Scop*. Hedge Mustard of England. Abundant in Dalhousie College grounds, Halifax. Pictou, A. H. Mackay.

BRASSICA SINAPIS, *Visiani*. *B. Sinapistrum*. Boissier, Wats., Gr. Man. Cadlock. Wild Mustard. In grain fields, a European weed, Cornwallis. Truro, very abundant in grain fields, introduced, Dr. G. C. Campbell.

BRASSICA NIGRA, *Koch*. Black, or True Mustard. Halifax, Dr. Lindsay. Parrsborough, Cumberland, Dr. How. (There is possibility of error in determining the species.)

BRASSICA ALBA, *Boissier*. In grain fields, sparingly, from foreign seed, but not permanent. Lucyfield, Halifax County.

DIPLOTAXIS MURALIS, *DC.* On ballast heaps at Pictou, and on ballast at North Sydney, Cape Breton, 1883, Macoun.

CAPSELLA BURSA-PASTORIS, *Moench.* Shepherd's Purse. An abundant garden weed in Halifax County, and probably throughout the whole Province. Waste places around dwellings, Truro, introduced, Dr. G. C. Campbell.

LEPIDIUM INTERMEDIUM, *Gray.* Pictou, A. H. Mackay.

LEPIDIUM RUDERALE, *Linn.* Windsor, Hants, and Sydney Bar, Cape Breton; Sydney Mines, 1859, How. Abundant on ballast heaps at Pictou, 1883, Macoun's Catalogue.

LEPIDIUM SATIVUM, *Linn.* Cress. Pepper Grass. Tongue Grass. Spontaneous in gardens where it has been grown and allowed to run to seed.

LEPIDIUM CAMPESTRE, *Linn.* On the wharf at Sydney, Cape Breton, 1883, Macoun.

SENEBIERA DIDYMA, *Persoon.* On ballast at Pictou; in the streets of Halifax; and on ballast at North Sydney, Cape Breton, Macoun's List.

SENEBIERA CORONOPUS, *Poiret.* A few specimens were found on ballast at Pictou, 1883, Macoun.

CAKILE AMERICANA, *Nutt.* Sandy sea-shores, common. Halifax Harbour. Pictou, Mackay and Lindsay. Oyster Pond, Guysborough, Rev. E. H. Ball.

RAPHANUS RAPHANISTRUM, *Linn.* A weed of cultivated grounds, introduced from Europe, where it is common.
Annapolis, A. H. Mackay.

CISTACEÆ.

HELIANTHEMUM CANADENSE, *Michaux.* Rock Rose. In open sandy woods at Kingston, Annapolis County, 1883, Macoun.

HUDSONIA ERICOIDES, *Linn.* On sandy flats on line of Windsor and Annapolis Railway, on borders of King's and Annapolis counties.

McNab's Island, Halifax, Dr. Somers. Abundant on rather dry rocks beyond the North West Arm, Halifax, and very abundant, in sand, around Kingston, Annapolis County, Macoun and Burgess. Near Kingston, P. Jack, sp.

VIOLACEÆ.

VIOLA CUCULLATA, *Aiton.* *V. palmata*, var. *cucullata*, Gray, Watson. Common Blue Violet. Moist fields, pastures, aud wayside banks, abundant. Very common in Halifax County. Truro, in grass fields, common, Dr. G. C. Campbell. In wet boggy places the leaves and flowers are smaller, the petals narrower and paler. We have no forms approaching *V. palmata*, Linn. One state, growing in Sackville, in light, dry soil, with large fleshy rootstock, numerous very large hairy leaves, and few very large ruddy purple flowers, may be distinct, or possibly a hybrid between *cucullata* and *sagittata*, with which two species it grows.

VIOLA SAGITTATA, *Aiton.* Arrow-leaved Violet. Formerly abundant at Lucyfield, on the banks of the Sackville River, but now almost extinct there. Large forms exist in Point Pleasant Park, Halifax, growing in earthy spots through the woods and on the drives, wherever the earth has beon disturbed.

VIOLA SELKIRKII, *Pursh.* "Vicinity of Windsor, Nova Scotia, McGill College Herbarium," Macoun's Cat. There is no further information respecting this rare species, which does not appear to have been found at Windsor in recent years.

VIOLA BLANDA *Willdenow.* Early White Violet. Sweet Violet. Very abundant in the woods around Halifax, in Sackville, Beaver Bank, and many other parts of the Province. A form with round-reniform leaves is called var. *renifolia.*

Truro, damp fields and swamps, very common, Dr. G. C. Campbell.

In "Hortus Kewensis, a Catalogue of the Plants cultivated in the Royal Botanic Garden at Kew, 2nd edition, by W. T. Aiton, Gardener to His Majesty," this common sweet violet of Nova

Scotia is entered as "introduced 1802, by H. R. H. the Duke of Kent." It is still very abundant in the woods surrounding the Duke's former residence, "The Prince's Lodge," on the western side of Bedford Basin, near Halifax.

This species was figured in Willdenow's Hortus Berolinensis (figures of plants that had flowered in the Berlin Botanic Garden), in 1804, two years after it was sent to Kew by the Duke of Kent, (Hort. Berol. fasc. II., t. 24). In noticing this work in Annals of Botany, Vol. I., p. 568, the editors, Konig and Sims, speak of the figure of the violet as that of "a nondescript elegant species, with white flowers, from North America," adding the remark: "We recollect to have seen it under the name of *V. pallens* in the garden of Mr. Forster, of Hackney (London), who has cultivated and studied a great number of species of this interesting genus." This latter remark serves to explain the synonym and reference in Roemer and Schultes' "Systema," Vol. V., p. 359, viz., "*Viola pallens*, Forster in Hackney," which has not been repeated by subsequent writers.

VIOLA PRIMULÆFOLIA, *Linn.* The Primrose-leaved Violet. A small patch of this rare species was found at edge of a swamp near the Three Mile Church, Halifax, (Fairview), during an excursion by the Botanical Class of Dalhousie College. This species presents characters intermediate in some respects between *V. blanda* and *V. lanceolata.* It was raised artificially from seed obtained from the Fairview station, and cultivated in the garden for several years; and, although less robust than either of its congeners, it did not show any tendency to revert or lose its distinctive characters. The specific name was originally spelt, in the Species Plantarum, *primulifolia,* and was so continued by succeeding writers until corrected by DeCondolle, in Prodromus, 1844.

VIOLA LANCEOLATA, *Linn.* Not rare about Halifax, as margins of Steele's Pond and around other pools in Point Pleasant Park, Dutch Village, Dartmouth Lakes, etc. Abundant and very fine on the black mud flats at Lily Lake, between Bedford and Rocky Lake. More sparingly in drier situations. Annapolis,

A. H. Mackay. This species was collected near Halifax towards the end of last century by Menzies, the botanist of Vancouver's expedition.

VIOLA ROTUNDIFOLIA, *Michaux*. Teny Cape, Dr. How. The existence of this species in Nova Scotia rests entirely upon Dr How's authority, and it is very desirable that search should be made for the plant at Teny Cape. In Dr. How's Notes, (Proc. Inst. Sc.), he remarks: "This pretty plant, the one yellow violet, of which there is a specimen in the Herbarium of Nova Scotia plants procured from me by the Provincial Commissioners for the Paris Exposition of 1867, I have only seen growing at the locality where that specimen was got, viz., at the Manganese Mine, in the woods, at Teny Cape, Hants County." It is possible that a mistake may have been made in the name, as Dr. H. speaks of this as "the one yellow violet," and does not mention *pubescens*, which has also yellow flowers, and is known certainly as a native. The two plants are easily distinguished, *V. rotundifolia* being a stemless violet, with all the leaves coming directly from the root, while *V. pubescens* has erect stems bearing the leaves, without any radical ones. Both have yellow flowers.

VIOLA PUBESCENS, *Aiton*. Glace Bay, H. Poole. Pictou, A. H. Mackay. Truro, Dr. D. A. Campbell, Dr. Lindsay. Strait of Canso, Rev. E. H. Ball. I once picked up a freshly gathered specimen of this plant on the railway platform at Bedford, but could not ascertain whence it came. It is not known to grow anywhere in the Halifax district.

VIOLA CANADENSIS, *Linn*. At the Newport Plaster Quarries, scarce, close by the station for *Adiantum pedatum*. The Newport plant is tall and erect, without underground shoots.

VIOLA CANINA, var. MUHLENBERGII, *Gray*. Truro, in woods, at Smith's Island, Dr. G. C. Campbell.

VIOLA TRICOLOR, *Linn*. Rocky Lake Station, Halifax County. No doubt a garden escape. Spontaneous in the garden at Lucyfield. This and *V. lutea* are the two original sources of the garden pansies, which have probably been subsequently improved

by intermixture of other large-flowered species. The annual field and garden weed *V. arvensis,* with corolla not exceeding the calyx, is, without sufficient reason, connected by many authors with *tricolor* as a subspecies or variety; it has not been found in Nova Scotia.

V. odorata, the Sweet Violet of England, has been found at Pictou, by Mr. Mackay, but merely as a garden escape.

CARYOPHYLLACEÆ.

SAPONARIA OFFICINALIS, *Linn.* Soapwort. An escape from cultivation. Near Twelve Mile House, Halifax County, (flowers double, pale rose color). Windsor, Hants, escaped, How.

SILENE CUCUBALUS, *Wibel.* Cow Bells. *S. inflata,* Smith. About dwellings, etc., Lucyfield, introduced, probably from Bay Chaleur, Gulf of St. Lawrence, where it is abundant.

Truro, lately introduced with lawn-grass seed, Dr. G. C. Campbell.

SILENE ACAULIS, *Linn.* Moss Campion. St. Paul's Island and Cape Breton Island, A. H. Mackay, in Macoun's Catalogue, I., p. 68.

SILENE NOCTIFLORA, *Linn.* Catchfly. Formerly a garden weed at Lucyfleld, but has not been observed of late years.

LYCHNIS ALBA, *Miller.* *L. vespertina, Sibthorp.* Annapolis, Dr. How. Probably a remnant of the French occupation.

LYCHNIS DIURNA, *Sibthorp.* *L. dioica, Linn.* Annapolis and Kentville. Probably a remnant of the French occupation.

LYCHNIS GITHAGO, *Lamarck.* Corn Cockle. In fields. Introduced with foreign seed-grain, not a permanent weed. Lucyfield, occasionally.

Halifax, Dr. Somers. Pictou, A. H. Mackay. Strait of Canso, Guysborough, Rev. E. H. Ball. New Glasgow, Dr. How.

ARENARIA SERPYLLIFOLIA, *Linn.* Sandy and gravelly soils, introduced. Halifax.

ARENARIA LATERIFLORA, *Linn.* Near Windsor, Dr. How. Near Halifax, Dr. Somers. Cow Bay, Halifax County, Dr. Lindsay. Pictou, A. H. Mackay. Truro, borders of woods, common; Smith's Falls; the Falls, etc., Dr. G. C. Campbell.

ARENARIA GRŒNLANDICA, *Spreng.* On rocks, North West Arm, Halifax, Macoun and Burgess, in Cat.

ARENARIA PEPLOIDES, *Linn.* *Honckenya peploides*, Ehrhart. Sea Purslane. Sandy sea shores, probably all around the coast. Halifax Harbour, abundant along sandy beaches. Pennant, Dr. Somers.

STELLARIA MEDIA, *Smith.* Common Chickweed. An abundant weed in gardens and fields, and about yards. A very large form, with elongated stems and long-stalked leaves, is found in garden frames and rich soils in sheltered situations. Halifax, Sackville, etc., abundant. Windsor, Dr. How. Pictou, A. H. Mackay. Truro, a common weed in gardens and damp places about dwellings, etc., introduced, Dr. G. C. Campbell.

STELLARIA LONGIFOLIA, *Muhlenberg.* Long-leaved Stitchwort. Common in places about Halifax, in Sackville, Rocky Lake, Beaver Bank, etc. Margaretville, Annapolis County, Dr. How. Truro Marsh, County of Colchester, in grass, common, Dr. G. G. Campbell.

STELLARIA LONGIPES, *Goldie.* Near Halifax, occasionally, but not common.

STELLARIA GRAMINEA, *Linn.* Beaver Bank. Abundant at Truro, Halifax, Windsor, and Annapolis, 1883, Macoun and Burgess. It is feared that our native species *longifolia* and *longipes* are mixed by collectors with the introduced European plant *S. graminea.* Specimens should be carefully examined.

S longifolia; leaves narrowed below, being broadest above the base, pedicels spreading, seeds smooth.

S. longipes; leaves broadest at the base, pedicels (long) erect seeds smooth.

S. graminea ; leaves broadest above the base, pedicels spreading widely, seeds rough (rugose).

STELLARIA ULIGINOSA, *Murray.* Margins of ponds, ditches, and wet places in the woods, around Bedford Basin, etc. Halifax County, A. H. Mackay. Common in small rills, Point Pleasant, Halifax, Macoun and Burgess.

STELLARIA BOREALIS, *Bigelow.* Magdalene Islands, A. H. Mackay.

CERASTIUM VULGATUM, *Linn.* Sp. Pl. Abundant in many places. Halifax Peninsula, Dartmonth, Bedford Basin, Sackville, etc. Our plant is perennial, with leafy barren shoots, hairy but not glandular, petals rather larger than the calyx, and it corresponds with *C. triviale,* Link. It agrees with the description in Species Plantarum, but not with Vaillant's figure and description of "*Myosotis arvensis hirsuta, parvo flore albo,*" upon which it is founded, which has small flowers, the petals equalling the calyx. It is not "clammy-hairy," as described in the 6th edition of Gray's Manual. Linnæus distinguishes his *vulgatum* as similar to *viscosum*, but more tufted, which seems of itself to identify our Nova Scotian plant with it; he notes *viscosum* as an annual.

CERASTIUM VISCOSUM, *Linn.* Sp. Pl. Owing to the confusion in names between this and the preceding species, I forbear giving special localities until specimens can be examined with care. Vaillant's figure of "*M. hirsuta altera viscosa,*" quoted for *C. viscosum* in Species Plantarum, has large flowers, with petals exceeding the calyx, whereas what is now regarded as the *viscosum* of Sp. Pl. by botanists generally, has small flowers, petals shorter than the calyx.

Two unfortunate mistakes, (1.) the misquoting by Linnæus of Vaillant's figures and descriptions in Botanicon Parisiensi, and (2.) the transposition of the specimens of these two species (*viscosum* and *vulgatum*) in the Linnæan Herbarium, have caused such confusion in the nomenclature of these plants, that many European botanists give up the two names as hopeless, and re-

name the plants. The most important function of a botanical name is to denote its particular plant; these two have been so mixed up, that they can now be hardly used for that purpose without explanation.

CERASTIUM NUTANS, *Rafinesque*. On the railway track at Windsor Junction, Halifax County. Several plants have been brought to this place with gravel from King's County, used in ballasting the railway track, but I noticed *C. nutans* long before the railway was extended to King's County, and it is no doubt indigenous.

CERASTIUM ARVENSE, *Linn*. On the trap cliffs at Blomidon, the true indigenous form of the plant. Truro, in gravelly soil, on the margins of the stream issuing from the Victoria Park.

Pictou, Macoun. Truro, in grass fields and on road sides; Wimburn Hill, Dr. G. C. Campbell.

SAGINA PROCUMBENS, *Linn*. Not rare on roadside banks about Halifax and Bedford Basin; between Twelve Mile House and Upper Sackville, Halifax County; Lucyfield, near St. John's Parish Church, Sackville; Dutch Village; North West Arm, etc.

Windsor, Hants, Dr. How. Very common at Pictou, A. H. Mackay. Common all around Truro, Dr. G. C. Campbell.

In Watson & Coulter's (sixth) edition of Gray's Manual, this species is described as "annual or perennial," p. 89. In Nova Scotia it is a decided perennial, each plant forming a compact tuft or cushion, with numerous short barren leafy, as well as long floriferous, shoots. *S. procumbens* is thus very different in habit from such annual species, as *S. apetala*, in which leaf-rosettes are scarcely formed. and all the shoots bear flowers. In the West and South, *S. procumbens* may be less tufted and more evanescent. Even the dandelion, which is such a persistent perennial in the cold swamps of the far north, becomes almost a biennial in the richer soils of Ontario, and in warm climates farther south.

SPERGULA ARVENSIS, *Linn*. Common Spurry. A European agricultural plant and weed, thoroughly established, and looks like a native. Lucyfield, Halifax County, abundant.

Truro, in grain fields, common, Dr. G. C. Campbell. Windsor, Dr. How. Halifax, Dr. Somers. Pictou, A. H. Mackay.

SPERGULARIA RUBRA, *Presl.* Sandy and gravelly places. Not rare about Halifax. Old Windsor Road, Sackville.

North Sydney, Cape Breton, Macoun. Windsor, Hants, Dr. How.

SPERGULARIA SALINA, *Presl.* Pictou, A. H. Mackay. North Sydney, Cape Breton, and Pictou, Macoun. Annapolis, Prof. Fowler, Macoun's Cat.

PORTULACACEÆ.

PORTULACA OLERACEA, *Linn.* Purslane. In cultivated lands, Cornwallis, King's County, an abundant and troublesome weed, introduced from Europe, and now widely spread over America, especially in the South and West. In France used as a salad, see Report of Secretary for Agriculture, N. S., for 1890.

CLAYTONIA CAROLINIANA, *Michaux.* Debert Mills, Colchester County, Dr. G. C. Campbell. Pictou, A. H. Mackay. Hall's Harbour, King's County, and Sherbrooke, Guysborough, Dr. How. Port Mulgrave, Rev. E. H. Ball.

CLAYTONIA VIRGINICA, *Linn.* Pictou, A. H. Mackay. Near Truro, Drs. D. A. Campbell and Lindsay.

MONTIA FONTANA, *Linn.* Blinks. Named for J. de Monti, an Italian botanist, a small, annual, glabrous herb, 1 to 5 inches high, flowers minute. In a meadow a little above the first fishing stage after crossing the North-West Arm, Halifax, Macoun and Burgess.

HYPERICACEÆ.

HYPERICUM ELLIPTICUM, *Hooker.* Wilmot, Annapolis, Dr. How. On the borders of ditches in Truro Marsh, Colchester, Dr. G. C. Campbell.

HYPERICUM PERFORATUM, *Linn.* Bushy places around Bedford Basin, originally introduced from England, and liable to

become a noxious weed in pastures, the juice being acrid, and the secretion of the glands said to be injurious to the eyes of cattle pasturing. Truro, in damp fields, introduced, Dr. G. C. Campbell.

HYPERICUM MACULATUM, *Walter*. *H. corymbosum*, Muhl. Halifax, Dr. Lindsay.

HYPERICUM MUTILUM, *Linn*. Truro, in wet woods, back of Terrace Hill Cemetery, Dr. G. C. Campbell. Windsor, Dr. How. Dartmouth, Halifax County, Dr. Lindsay.

HYPERICUM CANADENSE, *Linn*. Windsor, Dr. How. Halifax, Drs. Lindsay and Somers. Truro, sandy spots in the Marsh, common, Dr. G. C. Campbell.

ELODES CAMPANULATA, *Pursh*. *E. Virginica*, Nuttall. Abundant around the boggy margins of lakes, as Sandy Lake, Halifax County.

Windsor, Dr. How. Pictou, A. H. Mackay. Truro, common in swamps; Smith's Island, etc., Dr. G. C. Campbell.

MALVACEÆ.*

MALVA ROTUNDIFOLIA, *Linn*. Common Mallow. Windsor and Kentville, Dr. How.

MALVA MOSCHATA, *Linn*. By roadsides near Paradise, Annapolis County, probably escaped from gardens, (flowers rose-coloured). Sackville Mills, Halifax County, (flowers white).

Pictou, A. H. Mackay. Cape Breton, H. Poole, in How's list.

MALVA CRISPA, *Linn*. Pictou, rare, A. H. Mackay.

MALVA SYLVESTRIS, *Linn*. Ballast heaps at Pictou. I do not know whether it is permanently established.

The record of Sackville as a station for *Malva borealis*, in Catalogue, in Proceedings of the Institute, Vol. IV, p. 188, is erroneous, and was printed without my knowledge; the error is repeated in Macoun's Catalogue, Part I, p. 86.

HIBISCUS TRIONUM, *Linn*. Escaped from gardens, rare, A. H. Mackay.

*See Baker's recent papers in the London Journal of Botany.

TILIACEÆ.

TILIA PARVIFOLIA, *Hayne*, Arzneigewachse, III, t. 46 or 47, (1834). DC. Prod., XVII, p. 317. The common Lime Tree, or Linden.

A common street tree in the city of Halifax and the country towns.

Windsor, Hants, planted, Dr. How. This species, commonly called by the aggregate (and therefore objectionable) Linnæan name, *T. Europæa,* is our best shade tree for planting in the city of Halifax. It forms a compact head, stands pruning to any shape, and the roots form a ball so that the tree can be removed even after it has attained considerable age. In dry situations inland, the foliage is liable to be scorched in the hot season, but this rarely occurs near the seashore.

LINACEÆ.

LINUM USITATISSIMUM, *Linn.* Common Flax. Spontaneous in fields where flax has been grown, but not permanent; frequently found by waysides and along railroad tracks, where the seed has escaped in transit.

LINUM CATHARTICUM, *Linn.* On waste ground along the seashore at Pictou, Macoun and Burgess.

GERANIACEÆ.

GERANIUM MACULATUM, *Linn.* Windsor, Hants, Dr. How. In fields, Halifax, Dr. Lindsay.

GERANIUM CAROLINIANUM, *Linn.* Windsor, Hants County, Rev. J. B. Uniacke, (How's List). Elmsdale, A. H. Mackay.

GERANIUM ROBERTIANUM, *Linn.* Blomidon, amongst rocky *debris* fallen from the cliffs.

Spencer's Island, Cumberland County, and Marble Island, Cape Breton; also near Windsor, Dr. How. Pictou, A. H. Mackay. Manchester, Guysborough County, Rev. E. H. Ball. Whycocomagh, Cape Breton, and Pictou, Dr. Lindsay.

Several commcn European species of *Geranium* occur occasionally, and have been observed in fences and by roadsides at Pictou and elsewhere, but it is not known whether they are permanent.

Oxalis Acetosella, *Linn.* Wood Sorrel. Common in the woods in moist places. Halifax and Sackville, North Mountain, Kings, &c.

Windsor, Hants, Dr. How. Scot's Bay, King's County, E. A. Thompson. Truro, damp woods at the Falls; also ravine back of Terrace Hill Cemetery, Dr. G. C. Campbell. Pictou, A. H. Mackay. Strait of Canso, Guysborough County, Rev. E. H. Ball.

Oxalis corniculata, var. stricta, Savi. Common, especially in clearings in the woods. Halifax Peninsula, Bedford Basin, Sackville, etc.

Truro, in cultivated ground, common, Dr. G. C. Campbell. Windsor, Hants, Dr. How. Pictou, A. H. Mackay. Strait of Canso, Guysborough, Rev. E. H. Ball.

Impatiens fulva, *Nuttall.* Moist ground, and stony places, not uncommon about Halifax, as near Wellington Barracks, Dutch Village, etc.; Beaver Bank Railway station; Lucyfield, Middle Sackville.

Windsor; near Digby; Moose River, Digby County, Dr. How. Truro, in swamps around Smith's Island, Dr. G. C. Campbell. Pictou, A. H. Mackay. Whycocomagh, Cape Breton, Dr. Lindsay. Oyster Ponds, Guysborough, Rev. E. H. Ball. Halifax, Drs. Somers and Lindsay.

ILICINEÆ.

Ilex verticillata, *Gray.* Hollyberry Bush. Margins of Sackville River near Sackville Mills, and on hill top at Lucyfield, Halifax County.

Truro, McClure's Island, growing in wet ground, bordering on the Marsh, Dr. G. C. Campbell.

Ilex glabra. *Gray.* Inkberry. In low grounds along the river courses, Caledonia, Queen's County, abundant.

North-West Arm, Halifax, Col. Hardy, R. E., (How's List, 1876.) Near Shelburne, P. Jack. Near an old mill pond, North-West Arm, Halifax, Macoun and Burgess.

NEMOPANTHES FASCICULARIS, *Rafinesque.* Mountain Holly. *N. Canadensis*, DC. Halifax County and Pictou, A. H. Mackay, in Macoun's Cat.

CELASTRACEÆ.

CELASTRUS SCANDENS, *Linn.* Wax-Work. Introduced by Hon. Justice Ritchie, and now grown as an ornamental creeper in Halifax City and other parts of the Province.

EUONYMUS AMERICANUS, *Linn.* Windsor, Hants, cultivated, Dr. How.

VITACEÆ.

VITIS RIPARIA, *Michaux.* Northern Grape. The evidence in favor of the former and present existence of grape vines, presumably of this species, in Nova Scotia, is given and discussed in a paper published in the Proceedings of the Institute. It is very desirable that further inquiries should be made, and specimens obtained.

AMPELOPSIS QUINQUEFOLIA, *Michaux.* Virginian Creeper. American Ivy, Not indigenous in Nova Scotia, so far as known, but a common creeper on the walls and verandas of dwellings. Common in Halifax, especially in the older parts of the city, in the "north end." Windsor, Hants, cultivated, Dr. How.

SAPINDACEÆ.

ÆSCULUS HIPPOCASTANUM, *Linn.* Horse-Chestnut. An Asiatic tree, long cultivated in western Europe and America. In deep, porous, well-drained soils, it thrives remarkably well, but on heavy land it is not so vigorous, and is apt to be killed off in dry seasons. There are some fine old trees at Donaldson's, Birch Cove, on the western shore of Bedford Basin, near Halifax, at Windsor, and other places.

Pictou and Annapolis, A. H. Mackay. Commonly planted, Dr. Lindsay. Windsor, Hants, planted, Dr. How.

ACER PENNSYLVANICUM, *Linn.* Striped Maple. Snake Maple. Moosewood. Striped Dogwood. These names refer to the green glossy bark striped with dark blotchy lines. In wet woods, not rare in Halifax County; abundant around Sandy Lake.

Truro, ravine back of Terrace Hill Cemetery; the Falls, etc., common, in flower June 11th, 1884, Dr. G. C. Campbell. Windsor, Dr. How. Pictou, A. H. Mackay.

ACER SPICATUM, *Lamarck.* Spike-flowered Maple. Bush Maple. Rockingham, near Halifax, on the bank between the road and salt pond near St. Elmo Hotel, and at other points around Bedford Basin, as near Prince's Lodge, and on the Dartmouth side, but usually as single examples, and not common.

Truro, wooded banks at Bible Hill, Dr. G. C. Campbell. Windsor, Dr. How. Pictou, A. H. Mackay. Halifax, Drs. Somers and Lindsay.

ACER SACCHARINUM, *Wang.* Sugar Maple. Rock Maple. In the drier woods, rather scarce in Halifax County.

Windsor, Dr. How. Halifax and Cape Breton, Dr. Lindsay. Pictou, A. H. Mackay.

ACER RUBRUM, *Linn.* Common Maple. Red Maple. (Twigs reddish, flowers bright red, leaves changing to bright red tints in autumn.) Very general and abundant, especially along the courses of streams, and on the banks of lakes, in Halifax County.

Truro, on borders of swamps, and in wet woods, common, Dr. G. C. Campbell. Windsor, Dr. How. Pictou, A. H. Mackay.

ACER PSEUDO-PLATANUS, *Linn.* Plane Tree. Sycamore. Planted for ornament in Halifax city. Canning, King's Co., E. A. Thompson, 1873.

NEGUNDO ACEROIDES, *Mœnch.* Not indigenous in Nova Scotia, but occasionally planted as an ornamental tree. In Public Gardens, and elsewhere in the City of Halifax.

At Lucyfield, the form *N. Hectori*, Hort. Edin., raised from seeds collected by Sir James Hector, during the Pallisher expedition, is very hardy, and never suffers from severe winters, as the ordinary form of the tree does.

STAPHYLEA PINNATA, *Linn.*, which grows in shrubberies in England, is recorded by Dr. How as found at Windsor, cultivated.

ANACARDIACEÆ.

RHUS TYPHINA, *Linn.* Quite common along the banks of Bedford Basin, by the road from Halifax to Bedford, indigenous. Not recorded from any inland localities.

Cultivated at Windsor, Dr. How. Pictou, A. H. Mackay.

RHUS TOXICODENDRON, *Linn.* Poison Ivy. Plentiful in stony land, a few miles above Dartmouth town, belonging to the Admiralty, on the Dartmouth side of Bedford Basin; also near the shore to the westward of Bedford village, at the head of the Basin. In wild rocky lands, between Windsor Junction and Salmon Hole, Windsor Road, Halifax County. North-West Arm, Halifax. Close by the salt spring, Whycocomagh, Cape Breton, 1864. Abundant among stones, at the base of the cliff at Look Out, on the North Mountain, King's County, below the stations for *Woodsia Ilvensis* and *Asplenium Trichomanes.*

Cumberland, A. H. Mackay.

Stations should be carefully recorded, as some persons suffer severely from handling the plant, in ignorance of the injurious effects of its exhalations, or of the more sensitive parts of the skin coming in contact with it.

IX.—NOTES ON RAILROAD LOCATION AND CONSTRUCTION IN EASTERN CANADA.—BY WM. B. MACKENZIE, *Assistant Engineer I. C. Railway, Moncton, N. B., Canada.*

Reconnaissance.—It has been said that the engineer who can conduct a reconnaissance properly, is born, not made. He must have an eye for country, and depend mainly on his own natural tact and a judgment matured by experience.

Provided with the best available map of the country—the geological maps are the best so far published—one or more barometers, and a pocket-compass, the engineer notes the governing points and takes their height with the barometer. Two should be used, the readings being taken simultaneously at a series of intervals previously agreed upon.

While serving as a general guide, only approx. heights can be obtained by the barometer. One instrument alone should never be depended upon.

Sometimes when following a stream it is scarcely possible to go far astray, but when the waters run about at right angles to the line, the difficulties are much increased. Then the lowest points on the ridges and the highest banks at stream-crossings must be sought. Several routes are examined, that promising the greatest ultimate economy being generally selected, although, sometimes, for political and other equally reprehensible reasons, the best line is adorned with "curves of beauty," to the eventual discredit of the locating engineer, although he may be in no wise responsible for the mischief.

There is always one *best* line between any two points, and, generally speaking, not one-quarter enough money is spent in seeking it. The extra cost of the construction of the one *not* the best, like the sea-captain's mule-hire, "is there, but you can't see it." Some expert, standing on the platform of a Pullman car, 50 years after, may see it, when the country will have been cleared of wood, and the eye takes in miles at a glance.

Preliminary.—Next comes the preliminary survey, where the transit and level are employed. If location is at all likely to follow, an ordinary compass should not be used. The transit should be provided with a gradienter and a level on the telescope. The gradienter is very useful when running to a maximum grade. The preliminary should be run with such care that it will not deviate from the final location more than 200 or 300 feet at any point.

I will here give a description of the running of both preliminary and location simultaneously, by the writer. After the general reconnaissance had been made, and certain ruling points fixed, and when the preliminary party had been at work for one day, a location party was started. The engineer in charge provided himself with a wooden box 21″x28″ and 1¾″ thick, holding about 20 sheets of common drawing-paper, a brass ruler, protractor, 12″ scale, and a pair of 6″ compasses. On the front edge of the box were fastened a pair of leather handles, and a pair of brass hinges on the other edge. When this box was opened out and set up on four pegs, under the grateful shade of some wide-spreading tree by the boy who carried it, the engineer's office was located there for the time.

The engineer was almost constantly with the preliminary party, and gave directions to the location party from his own general notes and the results of the preliminary work. The sheets already referred to were 20″x27″ in size, numbered from 0 upwards. Every evening the transit-man of the preliminary party plotted his notes on these sheets, to a scale of 200 ft. to an inch. As the sheets were finished they were handed to the topographer, who recorded on both sides the line, the rise or fall above or below each station, or at distances two or three stations apart as the case might be, according to the roughness of the ground. These notes generally extended 100 to 300 ft. on each side of the line. While this was being done, the leveler had plotted up his profile. The engineer, then, with the help of the plan and profile, and a fine silk thread, laid down roughly the best grades possible between the most abrupt points on profile, and dotted on the plan the line which would give the least cut or fill for this grade.

Next the location was plotted on the plan, keeping as near to the dotted line as the limiting curves and grades would allow. Notes were then written on a slip of paper and sent back by the boy to the chief of the locating party. They would read somewhat as follows: " From Sta. 40 measure at right angles to the right, 36 ft. and fix a point. Then go to Sta. 45, measure 50 feet to the right, at right angles, and set up the transit here. Sight back to first point, run tangent to Sta. 65 of location. Then put in a 5° curve to right, to Sta. 75+50. Then run tangent to 80+40, and put in a 4° curve to left, etc.

By this means the engineer kept both parties hard at work, and, with the help of a saddle-horse, the box and the boy, did the necessary exploratory work ahead of the preliminary party, as well as making an occasional visit to the locating party.

Field-Books.—Both transit and level-books should begin at the bottom of the page, so that the topographical notes may be entered on the right-hand page, opposite the stations to which they refer. Both transit-man and leveler notes down crossings of streams and roads, and as much other topography as he has time for, without delaying his principal work, although the topographer is supposed to note everything necessary on preliminary work. On location, however, the transit-man takes all the topography, excepting land-lines and proprietors' names, which is best done by a land-surveyor.

Plans, Profiles, and Estimates.—Plans, profiles, and estimates of the located line are now made. The preliminary sheets are completed by laying down thereon the widths required for right-of-way, taking from the profile the widths of the widest banks and cuttings, and extra land for snow-fences, ballast-pits, etc. This, with the determining of the sizes and positions of culverts, bridge-spans, foundations, etc., calls for a special visit of the chief engineer, or an experienced assistant, to the ground, with plan and profile in hand. This is a point often neglected, or left to incompetent persons, and the results are unsuitable foundations and structures and an insufficiency of culvert-openings.

Plan.—The plan shows the stations at every 1000 ft., the plus stations at every land-line, change of width in right-of-way, stream and road-crossings, and cultivated or wooded land.

Profile.—The profile shows the cut or fill at every station in figures, the number of cubic yards in every cutting and embankment, and whether of rock or earth, the rates and changes of grades, the land-lines and the proprietors' names, kind of country—whether wooded or cultivated—names of roads and streams, together with every bridge, culvert, cattle-guard, etc., all in their proper places.

Estimates.—An estimate of cost is now made, and just here judgment and experience are much needed; an inexperienced man will estimate too low, and a timid or conservative man too high. Contracts are generally given to the lowest tenderer, although the engineer often knows he cannot but fail to complete the work.

Construction generally.—In an ordinary rolling country, railways can be built having stone culverts, steel bridges and 56-pound steel rails, ready for traffic, for about $16,000 per mile, exclusive of right-of-way.

Before the clearing is done, a plug is driven at every station, so that if the stakes are burned the plugs may still be found. After the burning is done, the stakes at the end of all curves, and also a few on the tangents, are referenced by carefully measuring to other stakes set outside the road-bed. From these latter, the original points are found after the stakes and plugs have been dug up by the workmen.

Every foundation for bridge or culvert is staked out, and the depths of excavation marked on the stakes. Each foundation is a special study, and should be tested with a boring apparatus before deciding upon the character of the foundation. If the bottom is gravel, or rock, nothing more is required. If, on the contrary, it is soft, then loose stone, concrete, a wooden platform or piles may be necessary. In no part of railway work is experience more needed than here.

Earth-work.—Shallow embankments are made up by scrapers from the sides, and shallow cuts are ploughed and scraped off from the top. Deeper cuttings are removed by trollies drawn by horses.

Sometimes, in a heavy cutting, the track is laid over the top of the hill, and some distance to one side, if it can be done without exceeding a grade of 3 or 4 ft. per 100, and steam-shovels are put to work at both ends, while the material is hauled away by locomotives and cars to make embankments at a distance. For this purpose temporary trestles are built over unfinished culverts and over depressions near which no material is obtainable for embankments. These trestles are finally left in place when banks are completed.

Ballasting.—Gravel ballast is generally brought by train. It is loaded on the cars by a steam-shovel, and unloaded by a plow, or by side-dump cars. The track is lifted twice, and the ballast packed under the ties with shovels, to a depth of 12 or 14 inches.

Approximate cost of grading the Road-bed:—

Kind of material.	Price per cubic yard.
Earth in cuttings	22c. to 28c
Frozen earth	31c. additional.
Earth in foundations	30c.
Hard clay	35c.
Hard pan	55c. to 70c.
Rock (loose)	55c. to 70c.
Rock (solid)	$1.15 to $1.50.
Excavation in water	80c, plus dry price.
Extra haul over 1000 ft.	¾c. per c. yd. over 1000 ft.
Filling by train from borrow-pit 1000 ft. from centre of bank	35c.
do. do. (3 mile haul)	40c.
Ballast	30c.

Box Culverts.—Dry stone work for box culverts has had its day, and it is not probable that in future it will be used to any great extent in this country. Culverts are now laid in lime and cement mortar, designed to vent water under a head, as an iron pipe would; no dry stone culvert can do this, and the attempt generally results in a washout. The side walls of box culverts are extended out beyond the end, or head walls, equal to height of culvert, so that in freshets, the opening cannot be obstructed by

drift-wood, for the water will rise, flow over, and fall into the opening between the obstruction and the head or end wall of the culvert.

Fixing the sizes of culvert-openings is a matter requiring great care. If possible, the engineer in charge should personally examine the ground and the character of the country drained by the stream, whether rough, rolling or flat. If county or geological maps exist, the drainage area can be gotten approximately. Then as a rough approximation we use Major E. T. D. Myers' formula:

$$A = C \sqrt{M}$$

A = Area of opening in square feet.
M = Drainage area in acres.
C = Variable coefficient = 1 for flat ground, and $1\frac{6}{10}$ for hilly compact ground.

Highway-bridges and openings over the same stream are examined, and the highest freshet-level obtained from "the oldest inhabitant." With this information, Myers' formula, and some brains, the openings will not be far wrong.

Culverts are seldom made less than $2\frac{1}{2}$x$2\frac{1}{2}$ ft., so that a man can get through to clean them out, and their fall not less than 3ins. per 100 ft. The head walls of box culverts are carried down 4 ft. below paving, and the side walls 3 ft., to prevent frost from acting on them. Where they are over 3 ft. span, the two upper courses are corbeled out to reduce the span of the covers. Proportions and quantities are about as follows:

Area sq. ft.	Size of opening in ft.	Thickness of Walls in ft.	Thickness of Covers, inches.	Length of Covers, in ft.	Masonry in shaft per ft. run, Cubic yards.	Masonry in two ends, Cubic yards.	Paving per ft. run, Cubic yards.	Paving at both ends, Cubic yards.
4	2 x 2	$2\frac{1}{2}$	12	5	0.963	10.963	0.074	3.12
5	2 x $2\frac{1}{2}$	$2\frac{1}{2}$	12	5	1.053	11.660	0.074	3.12
8	2 x 4	$2\frac{1}{2}$	12	5	1.340	13.920	0.080	6.80
9	3 x 3	$2\frac{1}{2}$	16	6	1.225	14.000	0.080	6.80
10	$2\frac{1}{2}$ x 4	$2\frac{1}{2}$	12	$5\frac{1}{2}$	1.380	14.200	0.100	8.00
12	3 x 4	$2\frac{1}{2}$	16	6	1.410	14.540	0.110	8.40

Double box culverts are now rarely used; the middle wall collects driftwood and may cause trouble. Arches are used instead. The cost of box culvert masonry may be estimated as follows :—

Coursed masonry laid in lime and pointed with cement,	$8.00	p.c.y.
Paving in bottom and at ends	5.00	"
Riprap at ends (hand-laid)........................	2.00	"
Excavation in earth	0.30	"

Arch Culverts.—Arch culverts should be built, generally, with splayed and stepped wings deflecting 30 degrees from the longitudinal line of the culvert. Right-angled wings, with buttresses, for upper end, and straight stepped wings for lower end, have been much used in Canada, but splayed wings are now considered the best practice. There should be no recess or shoulder where the wings join the head wall, to collect drift-wood and cause scour. When the ends are funnel-shaped, as above described, the discharge is increased 100 % over the square-end culvert, when discharging under a head.

The following dimensions may be used for arch culverts :

Culvert Opening.	Thickness of Wall at Springing.	Thickness of Wall at Upper Surface of Paving.	Thickness of Arch Stones.	Remarks.
4 ft.	2½ ft.	3 ft.	15 ins.	Circular Arch.
5 "	3 "	3½ "	18 "	"
6 "	3¼ "	3¾ "	18 "	"
8 "	4 "	5 "	21 "	"
10 "	4¼ "	5¼ "	21 "	"
12 "	4¼ "	6 "	24 "	"
15 "	5½ "	6½ "	24 "	"
20 "	7 "	7 "	18 "	Segmental brick arch Rad. 12½ ft., Rise 5 ft.

Iron Pipes for Culverts.—When iron pipes are used the following sizes will be sufficient for the given area, in places where water can be backed up to discharge under a head:

Area drained up to	Iron pipe.	Embankment exceeding nine feet.
15 acres.	2 ft. dia.	"
25 "	2½ "	"
60 "	3 "	"
90 "	3½ "	"
150 "	4 "	"

The dimensions given in the foregoing tables have been extensively used on first-class work in this part of the country.

Arch culvert stone masonry costs about as follows:

DESCRIPTION.	Cost of Stone per cubic yard.	Labor per cubic yard.	Freight per cubic yard.	Total per cubic yard.
Abutment walls..........	$5.00	$4.13	$......	$......
Arch	5.00	5.13	......	......
Cement concrete	5.00	to 8.00	per cubic	yard.

Retaining-Walls.—For retaining earth, the mean thickness of stone walls are usually made one-third of the height, the top, middle, and bottom thicknesses varying, as 3, 5, and 7. Walls should be calculated to resist overturning, and also sliding at the base, using the following:

Co-efficient of friction of rubble masonry		on wet clay,	0·2 to 0·33
"	"	moist clay,	0·33
"	"	dry clay,	0·51
"	"	dry earth,	0·50 to 0·66
"	"	sand,	0·66 to 0·75
"	"	gravel,	0·66 to 0·75
"	"	dry wooden platform,	0·60
"	"	wet "	0·75

The ground in front of the wall should not be counted upon to assist in the support of the wall, and a factor of safety of not less than 3 should be used.

Safe pressures on foundations under walls.—

Safe pressure on	Gravel..........	2 to 3	tons per	sq. ft.
" "	Sand..........	"	"	"
" "	Loam...........	1½	"	"
" "	Silt and Alluvium	1 ton		"
" "	Clay...........	1 to 2½	tons	"

Bridge-Piers and their foundations.—Masonry piers for bridges will cost from $8 to $15 per cubic yard, exclusive of the foundations on which they rest.

For 50 ft.	span,	make piers	4 ft.	thick	under coping.
" 100	"	"	5	"	"
" 150	"	"	6	"	"
" 200	"	"	7	"	"
" 250	"	"	7½ to 8 for piers 80 ft. high.		

Sides and ends of piers batter half inch or three-quarter inch per ft. Abutments batter one inch per ft.

Where sloping ice-breakers are not required, a round-ended pier is the best shape.

Grouting should not be used in first-class work, but flush up fully with cement mortar as built.

Foundation piles driven and cut off with a saw, under 12 to 14 ft. of water, will cost 35 cents per lineal ft. of part remaining in the work (say 17 ft.)

The best formula for pile driving is—

$$L = \frac{2\ WH}{S + 1}$$

in which

L = safe load in lbs.

W = weight of hammer in lbs.

H = fall of hammer in feet.

S = penetration in inches under last blow.

Where piles are driven under abutments on land, 12 inches of concrete is placed around pile-heads, 12″x12″ caps are then put on, and a course of timber laid close, to carry the masonry.

In calculating the weight on the earth under the abutment, draw lines from outer edges of bed-plates on an angle of 30 degrees with the vertical, down to the foundation, and assume that the live and dead loads, and also the weight of the masonry within those lines are all concentrated on the space between the points where these lines meet the foundation. This length multiplied by the thickness of the wall, or width of grillage, etc., gives the number of square feet over which the whole weight is supposed to be distributed.

The weight of rolling-stock has so increased in the last twenty years that iron bridges are now being removed and replaced by heavier steel structures, all over the country. The designer has now to ask himself: "Am I designing for five, ten, or for fifty years?" If a thoughtful man, he will not sail too close to the wind in proportioning his bridges, but provide a margin to meet future increased weight of rolling-stock.

Types.—For spans up to 15 ft., use rolled beams.
" from 15 to 80 ft., use plate-girders 8 ft. c. to c.
" from 80 to 100 ft., riveted Warren girders.
" from 100 to 150 ft., single intersection pin-connected Pratt trusses, with parallel or arched top chord, 14 ft. to 16 ft. clear width inside.
" from 150 to 550 ft., double intersection pin-connected Pratt trusses, with parallel or arched top chord.

Up to 225 ft., 14 ft. clear width min. Max. 16 ft.
225 to 320 ft., 18 ft. center to center.
320 to 420 ft., 21 ft. "
420 to 550 ft., 25 ft. "

Cost, etc., of Steel Bridges (metal only), designed for Typical Consolidation Locomotives. Compiled from formulas by G. H. Pegram, C. E. (Trans. A. S. C. Engrs., Feb. 1886.)

Length ft. (1)	Deck or Through. (2)	Type. (3)	Steel or Iron. (4)	Weight per ft. lbs. (5)	Total weight lbs. (6)	Cost per lb. (variable.) (7)	Price per ft. run. (8)	Cost for Metal erected. (9)
30	Deck.	Plate girders	Steel	425	12,750	4 cts.	$17 00	$510 00
35	"	"	"	460	16,100	4 "	18 40	644 00
40	"	"	"	525	21,000	4 "	21 00	840 00
45	"	"	"	550	24,750	4 "	22 00	990 00
50	"	"	"	580	29,000	4 "	23 20	1160 00
55	"	"	"	620	34,100	4 "	24 80	1364 00
60	"	"	"	650	39,000	4 "	26 00	1560 00
65	"	"	"	675	43,575	4 "	27 00	1743 00
70	"	"	"	715	50,050	4 "	28 60	2002 00
75	"	"	"	750	56,250	4 "	30 00	2250 00
80	Thro' riveted	Warren	"	775	62,000	4½ "	34 88	2790 00
85	"	"	"	800	68,000	4½ "	36 00	3060 00
90	"	"	"	830	74,700	4½ "	37 35	3361 50
95	"	"	"	860	81,700	4½ "	38 70	3676 50
100	"	"	"	900	90,000	4½ "	40 50	4050 00

For double track add 90 %.—Cols. 7, 8 and 9 will vary with the market price of steel.

Bridge-Erection on Railways in operation.—Plate-girders up to 75 feet span are usually riveted up complete, run into place on cars, and lowered on to the masonry by four screws working through overhead caps, supported on two posts at each end of bridge.

Deck bridges from 75 feet to 100 feet are riveted up complete, run into place on cars, jacked up, and the weight taken on blocks hung from overhead gallows-frames. The cars are then run out and the old bridge removed, when the new bridge is lowered to its place on the masonry by means of the blocks.

Through bridges may be placed the same as Decks, by spreading the old trusses far enough to let the new bridge in between

X.—FERTILIZERS ON SANDY SOIL.—BY PROF. H. W. SMITH, B. SC., *Provincial Agricultural School, Truro, N. S.*

The soil of the farm for the Provincial School of Agriculture possesses a very fine texture and is of the same constant character throughout the entire farm. It is formed from the red sandstone and was evidently made up in the same way as any sand bank at the side of the mouth of a river opening into the Bay of Fundy. The soil varies from five to thirty feet deep and has underlying it at least one hundred feet of red sandstone rock. How much more is not known. The sub-soil is of the same character as the soil. This sandy soil is very fine, almost an impalpable powder. It is easily tilled, fairly fertile, yielding about twenty bushels of barley cr two hundred and twenty-nine of potatoes per acre, in each case without manure.

We propose to make a careful investigation of this soil and its relations to plant growth. These investigations will be conducted by some of the students of the School under my directions. At present they are pursued as follows: the analysis of the soil and the effects of fertilizers upon it, by Mr. Trueman, and the relations of plants to the soil by Mr. Moore. It is hoped that by the next session of the Institute a report of progress in this work can be made. In the present paper we will try to point out lines along which our work will lie and some experiments which will enable us to work more intelligently.

Many experiments have been conducted by investigators upon the characters of soils and their relations to fertilizers and plants. But our conditions are so different that they afford us only general information and on many points none. With a climate approaching that of England in rain-fall but very much colder, the valuable experiments of Lawes and Gilbert are scarcely applicable here. Again their experiments were conducted on very fertile soil. Most of our soil would not compare with it. In the same manner, it could be shown that other experiments are not applicable for similar reasons.

This paper then will form a preface to further contributions.

PART I.

The Physical and Chemical Properties of the Soil—Its relation to Manure.

Johnson classifies the physical properties of the soil as follows: 1. Weight of soil; 2. State of division; 3. Hygroscopic capacity; 4. Power of condensing gases; 5. Power of fixing solids from solution; 6. Capillary power; 7. Change of bulk on drying; 8. Adhesiveness; 9. Relations to heat.

These properties of our soil are now under investigation. We may point out certain peculiarities, however. It is very fine silicious sand, so fine that it is scarcely gritty. When crops are suffering from drought on other soils in the same locality, those on our soil do not seem affected to such a degree. Not much change of bulk takes place on drying. (?) It is not adhesive and is a very warm soil. Although we have had the farm only two years, it shows marked effects the second year from the application of fertilizers the first. These are the indications as to the physical characters of the soil; they may be considerably modified by analysis.

The chemical composition of the soil cannot now be discussed further than to call attention to facts directly used in this paper, discarding the so-called inert material of the soil for the present.

Nitrogen is found in soils in the form of ammonia, nitrates and insoluble organic compounds. The ammonia usually exists in the soil either as double salts with insoluble bases or as double silicates. A small amount always exists in solution, as it is during the warmer season constantly being formed, or absorbed.

Nitrates probably exist in the soil in the form of nitrates of potash, ammonia, soda, lime and magnesia. The insoluble forms of Nitrogen are in most cases not available unless converted into ammonia or nitrates.

Nitrates are not fixed by the soil like the ammonia, but exist there for the most part as freely soluble.

Phosphoric acid, although so important to the plant, occurs very sparingly in the soil. It is there in the form of lime, iron, magnesia, and aluminium phosphates, all more or less insoluble.

Potassium occurs in the form of silicates, especially hydrated silicates. It is not abundant.

A discussion of the other constitutents is not required in this paper.

" From a great number of experiments made by Way, Liebig, and many others, it seems to be established as a general fact that all tillable fields are able to decompose salts of the alkalies and alkali-earths in a state of solution in such a manner as to retain the base together with phosphoric and silicic acids, while the hydrochloric, nitric and sulphuric acids remain dissolved in union with some other base besides the one with which they were originally dissolved."

This power varies in regard to the time required, the completeness of the absorption, and the quantity absorbed. It is increased by adding bases to the soil and diminished by treating the soil with acids. It is probably due to hydrated double silicates. It is a part of good farming to increase them. We find them very abundant in the rocks around the Bay of Fundy and possibly they may in a measure account for the fertility of our marsh lands.

It may also be added that when one base is introduced into a soil it usually, more or less, displaces some other base, but it has not been shown that this invariably follows. Ammonia is least readily displaced and potassium follows next.

Phosphates are probably retained by the soil by the production of insoluble double phosphates.

Bases may be retained by the formation of double salts, especially with iron hydrates.

The Effect of Fertilizers and Manure upon the Soil.

The probable effect of the application of ammonia salts to the soil would be to slightly increase its absorptive power. This would be still more marked with potassium compounds and sodium nitrate—the only form in which we apply nitrates. Most of the ammonia from manure is converted into nitrates, but how far this is true of ammonia salts is not known. Phosphates

would in a short time become insoluble double phosphates. With manure the case is different. All our manure is applied before fermentation begins. It contains no ammonia, but presumably ammonia is formed in the soil from the soluble nitrogen compounds it contains. The conditions which would tend to cause this change would be such as would favor nitrification, and the ammonia would immediately be converted into nitric acid. These conditions are decaying organic matter in contact with the soil containing nitrifying ferments. When ammonia salts as a fertilizer are applied, such is not the case, and the salts, if applied in any considerable quantities, would retard the action of the ferments, or might even kill them. This is only a surmise till we have investigated it more fully; but whatever the cause, ammonia salts, as will be shown, appear actually iujurious to most of our crops, especially potatoes. This we suggest as an explanation till we have found out what is the truth. Phosphates, whether in manure or not, soon become precipitated into insoluble phosphates. These are dependent on what bases are most abundant in the soil. In manure the phosphates are, like all the other constituents, very finely divided, and the decomposition of products of the manure tend to hold the phosphates longer in solution or to dissolve those freshly precipitated. This would not be the case with phosphates of fertilizers, for they have no organic decaying matter in close proximity to them unless we except fine ground bone, and that class of fertilizers. The potassium is present first as carbonate, then as rapidly as nitric acid forms it would be combined with it and with the other organic acids present. Its tendency would be to pass over into the zeolites in a short time.

PART II.

Plants:—Their Composition and Relation to the Soil.

The elements essential to agricultural plants are potassium, calcium, magnesium, phosphorus and sulphur. Besides there are constantly found in plants, iron, chlorine, sodium and silicon. Iron undoubtedly is indispensible to the growth of plants. Chlorine might possibly be added also. In regard

to sodium and silicon the case is different, and we will take time to point out that probably these are not required for plants, —especially as it is often erroneously taught that plants require them, particularly the latter, to strengthen their stalks. It appears from experiments that sodium cannot be wholly excluded from plants on account of its universality, but that in so far as it is or can be excluded, the plants do not suffer for it. Silicon is always present in the plant when grown under natural conditions. It occurs in largest proportions in the outer portions of the plant, especially the bark and leaves, and in the parts surrounding the seeds. It varies very much in the same and in different plants. The amount present depends on the amount of it soluble in the soil. Sachs has shown that the amount in the ash of the Indian corn could readily be reduced from 18% to 7½% without injuring the growth in the least. Knop grew a maize plant with 140 ripe kernels in a medium so free from silicon that there was only a trace of it found in the root, but half a milligram in the stem, only 22 milligrams in the leaves, and none in the seed. Knop thought that the little that he found was due to dust and was not present in the tissues. He says, "I believe that silica is not to be classed among the nutritive elements of the Gramineæ, since I have made similar observations in the analysis of barley." In experiments conducted by Sachs, Knop, Nobbe, and Siegert, Stohmann, Raute, Rautenberg and Kuhn, Birner and Lucanus, Leydbecker, Wolff and Hampe, it was, as far as possible, excluded from the food of plants grown in glass vessels, without any injurious effects to the plants. A number of plants of different species have been grown to full development without an appreciable amount of it being present.

Davy supposed that the function of silicon was to serve as a support to the plant as bones do to the body of an animal. But we find that the proportion of silicon is not greatest in those parts which require the greatest strength. The analysis of the oat shows that the upper part of the stem and leaves contain more silicon than the lower part of the stem, which certainly requires to be the strongest. In the experiments above, the stem was not weakened in the least when grown without this

element. A sample of wheat straw was brought to our attention from New Annan, Colchester County, and the farmer complained that just at harvest time the straw, especially wheat, broke off just below the head, and that he lost a considerable amount of grain from this cause. When the straw was analysed it was found to contain a large percentage of silicon in the upper internode just below the head where it broke. Again the wood of our various trees is surely strong, but it possesses scarcely any ash, and of this ash only a small part is Silicon. The bark, however, which is so brittle and weak often possesses a large percentage.

Of the volatile parts of the plant only a word is required. Plants obtain their nitrogen from the compounds in the soil. It is possible that the clover may obtain a little from sources that are not available to other plants, but it is not necessary to discuss the point here. The most of our cultivated plants depend on nitrates and ammonia, and can possibly use one or two of the other forms of combined nitrogen in the soil.

Of all the constituents of the plants mentioned above, only three are usually in such small quantities or in such insoluble forms in the soil that the plant cannot obtain them. In order to be unavailable to the plant, they must be locked up in quite insoluble forms, for the plant is able in a measure to make its own solution. It can undoubtedly dissolve out bases from the hydrated silicates, and, probably, also put double salts containing potassium or ammonia in solution. Double phosphates containing alkalies are probably often soluble to the roots.

Our soil is a sandy soil. These are held in bad favor by popular opinion. They are called leachy. They are said to possess all that a soil should not have, and none of those properties which a soil should have. Fortunately their reputation is worse than they are. The effect of the application of fertilizers to them would be in the highest degree to increase the absorptive power for valuable constituents except nitrates. These it might be expected would be washed out of sandy soils more rapidly than from other soils. Every application of fertilizers would increase its absorptive power for other constituents. As to how far these plant foods are likely to be washed out again,

is a subject for investigation, They should be in a very available condition for the plant. Manure, when applied to such soils, would increase their retentive power for water, and by its decay in the soil might improve their physical and chemical properties immensely.

PART III.

What does our Soil Require?

The problems that presented themselves to us on taking possession of the farm for the School in the late fall of 1888 contained among others the following questions:—

What plant foods are there in the soil?

How abundant, and how accessible to the plant?

Is the difference in demand made by the different crops shown by application of fertilizers?

In order to answer these questions, some experiments were undertaken as soon as we obtained possession of the farm. These were confined to Nitrogen, Phosphorus and Potassium. In each application of fertilizer a slight excess over what it was thought would be required for the plant was used. The same amount of each was used when used together. Forty-two separate trials were made during the past two years, the results of which are recorded in this paper. Instead of giving the amount of the different yields, I have reduced the increased yield to per cent. of increase over the unmanured plots. This enables us to compare the results one with another much more readily.

The table gives the year, the crop, the fertilizer applied, and the per cent. increase. In each set of experiments the plots were treated exactly alike in every other respect. It will be observed that each ingredient increased the yield when applied alone, that as a rule, when two were applied together the inerease was greater than when a single ingredient was applied, but not double that of either, finally, that when three were applied, the increase was often over three times that caused by a single ingredient. The results from manure on potatoes are worthy of notice.

The Nitrogen was applied as Sodium Nitrate and as Ammonium Sulphate, Potassium as Potassium Sulphate and Chloride, Phosphorus as Mono-, Di- and Tricalcic Phosphates.

TABLE I.

Showing the per cent. of Increase of each Crop from the Application of different Fertilizers.

Fertilizer.	Crop.	Year.	Per Cent. Increase.	Average.	
$NaNO_3$	Potatoes	1889	12.2		
"	"	1890	6.3		
"	Grass	1889	7.6	17.4	
"	"	1890	43.5		
$[NH_4]_2SO_4$	"	1889	9.		
"	"	1890	38.	14.4	20.8
"	Potatoes	1890	3.9 Dec.		
" and $NaNO_3$	Oats	1889	30.8	30.8	
K_2SO_4	"	1889	21.5		
"	Grass	1889	2.3		
"	"	1890	.33	11.2	
"	Potatoes	1889	24.		
"	"	1890	7.9		
$Ca_3P_2O_8$	"	1889	30.7		
"	Oats	1889	10.1		
$CaH_4P_2O_8$	"	1889	14.3		
"	Potatoes	1889	21.1	24.9	
"	"	1890	20.		
"	Grass	1889	32.		
"	"	1890	45.4		
$NaNO_3$ and K_2SO_4	Potatoes	1890	31.7		
" "	Barley	1890	16.7	20.7	
" "	Oats	1889	13.7		
" and $CaH_4P_2O_8$	Potatoes	1890	20.	—	
" "	Oats	1889	37.9		
$(NH_4)_2SO_4$ and "	Potatoes	1890	11.2	11.2	
" and $K_2S\ O_4$	"	1890	4.2	4.2	
$NaNO_3$ and $Ca_3P_2O_8$	"	1889	5.		
" and $Ca\ H_4P_2O_8$	Barley	1890	14.4		
" "	"	1890	50.		
K_2SO_4	Oats	1889	21.5		
" "	Barley	1880	56.	48.1	
" "	"	1880	66.9		

Fertilizer.	Crop.	Year.	Per Cent. Increase.	Average
K_2SO_4 and $NaNO_3$	Grass	1889	65.3	
" "	"	1890	155.8	
" "	Potatoes	1889	23.	
" "	"	1890	61.2	75.6
" "	Oats	1889	43.3	
" "	Barley	1890	73.1	
" "	"	1890	107.7	
" $(NH_4)_2SO_4$	"	1890	81.1	
" "	Potatoes	1890	8.	36.7
Farm manure	"	1889	65.5	
" "	"	1880	38.7	52.1

Table I shows that the increase from

Nitrates used alone	averaged	17.4
Ammonia "	"	14.4
Nitrates and Ammonia	"	20.8
Potash	"	14.2
Phosphates	"	24.9
Nitrates and Potash	"	20.7
" " Phosphates	"	25.4
Ammonia and Potash	"	4.2
" " Phosphates	"	11.2
Potash and Phosphates	"	48.1
Nitrates, Potash and Phosphates	"	75.6
Ammonia, " "	"	36.7
Farm Yard Manure	"	52.1

Of the three constituents, Phosphates gave the largest yield when used alone, Phosphates and Nitrates the largest yield of the two combined on potatoes, and Phosphates and Potash the largest yield on grains.

Nitrates gave better results than Ammonia, either alone or in combination with the other fertilizers.

These experiments have extended over about twenty-five acres of the farm, and have been repeated a number of times.

They seem to indicate that—

Our soil has a similar composition over the entire farm;

All the above constituents when applied increase its fertility;

Phosphates appear the most useful;

Nitrates are more valuable than ammonia

It depends upon the crops as to the proportion of the different constituents to apply.

Further tests are required to show —

What constituents the respective crops require;

The effect of continued application of the three different fertilizers to the same soil;

To confirm or correct indications.

Nothing has been said of the relative profit of these fertilizers, as that has nothing to do with the problem before us. Some of them were, however, extremely profitable.

XI.—On the Variation of Density with Concentration in Weak Aqueous Solutions of Cobalt and Nickel Sulphates.—By A. M. Morrison, B. A.

(Received July 25th, 1891.)

In a paper which I had the honor of reading before the Institute last session,* I gave the results of a short series of observations of the density of weak aqueous solutions of Cobalt Sulphate. The solutions used were prepared by mixing weighed quantities of water and of crystals of the salt, which, on what seemed to be satisfactory information, were taken to be heptahydrated crystals. The amounts of anhydrous salt present in the solutions used were calculated on this assumption.

On comparing the differences between the specific volumes of these solutions and the volumes, in the free state, of their constituent water, with similar differences in the case of solutions of other sulphates, as determined by Prof. MacGregor,† it was evident that either the dilute solutions of this salt exhibited the phenomenon of contraction in a very remarkable manner, or that the information on which I relied as to the constitution of the crystals used was incorrect. I therefore made several careful chemical analyses of the crystals and found that they contained not seven but six molecules of water.

This being so, the constitutions of the solutions whose densities are given in the paper referred to, are consequently inaccurately specified. I have therefore re-calculated them, and the results are given in the first two columns of the following table:

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* Trans. N. S. Inst. Nat. Sci., Vol. VII (1890) p. 480.

† Trans. Roy. Soc. Can., Vol. VIII (1890) Sec. iii, p. 19.

Percentage of anhydrous Co SO_4 in solution.	Density at 20° C. (Grms. per cu. cm.)		Difference.
	Observed.	Calculated.	
0.6952	1.00552	1.00554	+ 0.00002
1,6373	1.01533	1.01540	+ 0.00007
1.8558	1.01766	1.01768	+ 0.00002
2.5926	1.02541	1.02539	− 0.00002
2.9654	1.02954	1.02929	− 0.00025
5.3693	1.05498		
8.5699	1.09047		

These corrected results agree much more closely with Nicol's* observation, which gave 1.04123 as the density at 20° C. of a solution, containing 4.1434 per cent. of the anhydrous salt, than the erroneous results formerly published. Graphical treatment of the above results gives 1.0418 as the density of Nicol's solution. They agree much less closely with Wagner's† result, which gave 1.0860 as the specific gravity of a solution containing 7.239 per cent. of salt. This observation was made at the temperature of the laboratory, which is not given in his paper. The temperature of the water to which his specific gravities are referred is also not given, If we assume that the temperature of the laboratory was 15° C., and that the specific gravity given by him is referred to water at the same temperature, and if we further assume that the thermal expansion of the solution under consideration is practically the same as that of water, we find for the density (in grammes per cubic centimetre) of this solution at 20° C., the value 1.0841. My observations treated graphically give 1.0755 as the density of this solutiou. Probably, therefore, the above assumptions made in calculating Wagner's density are not correct.

* Phil. Mag., Ser. 5, Vol. XVI (1883) p. 122.

† Wied. Ann., Bd. XVIII (1883) p. 269.

Prof. MacGregor* having shown that in the case of a great many salts, the curves exhibiting the relation of the density of dilute solutions to their percentage composition, are practically (to the fourth decimal place of the density when it is expressed in grms. per cu. cm.), straight lines, I have thought it well to determine to what degree of concentration the same is true for solutions of this salt. I find that the first four of the above observations may, to the fourth place of decimals, be represented by the formula —

$$D_{20} = 0.99827 + 0.01046\,p.$$

where D_{20} is the density of solutions at 20° C., and p the percentage of anhydrous salt in solution, 0.99827 being the density of water at 20° C. according to Volkmann.† The third column of the above table gives the densities of the first five solutions calculated by means of this formula, and the fourth column, the amounts by which the calculated values exceed the observed values. It will be seen that for solutions containing 2.6 or 2.7 per cent. of anhydrous salt, or less, the curve referred to is, to the fourth place of decimals, a straight line.

Nickel Sulphate.

No observations of the density of very dilute solutions of Nickel Sulphate having, so far as I know, been made hitherto, I have made the few which were necessary to extend our knowledge of the density of solutions of this salt to extreme degrees of dilution. The solutions were prepared and their composition and density determined in the way described in my former paper, referred to above. The results obtained are given in the first two columns of the following table: —

* Trans. Roy. Soc. Can., Vol. VII, (1889), Sec. iii, p. 23.

† Wied. Ann., Bd. XIV. (1881), p. 260.

Percentage of anhydrous Ni SO_4 in solution.	Density at 20° C. (Grms. per cu. cm.)		Difference.
	Observed.	Calculated.	
1.2512	1.01155	1.01158	+ 0.00003
2.0799	1.02046	1.02040	− 0.00006
3.9633	1.04064	1.04044	− 0.00020

The only results by which we can check the above are Nicol's single observation* and Favre and Valson's series of observations.† Nicol found that a solution consisting of half a molecule of crystallised salt to 100 of water has, at 20° C., a specific gravity, relatively to water at 20° C., of 1.04296, or, as a simple calculation will show, that a solution containing 3.9711 per cent. of anhydrous salt has a density, in grms. per cu. cm., of 1.04116. Graphical treatment of my observations gives 1.0408 as the density of this solution. The weakest solution examined by Favre and Valson consisted of 14.05 parts of crystallised salt and 100 parts of water, and therefore contained 6.772 per cent. of anhydrous salt. The next weakest contained about twice this percentage. The densities of solutions so strong as these cannot be found by the aid of my observations above. But if a curve of densities *versus* percentage compositions be plotted by means of my observations and theirs combined, it shows no discontinuity between the two portions.

The following formula represents to the fourth decimal place the densities of solutions of this salt up to a concentration of about 2.5 per cent.:—

$$D_{20} = 0.99827 + 0.0164\,p.$$

The densities calculated by means of this formula are given in the third column of the above table, and the amounts by which

* Phil. Mag., Ser. 5, Vol. XVI, (1883), p. 122.

† Comp. Rend., T. LXXIX, p. 968.

the calculated values exceed the observed values are given in the fourth column. They will be seen to bear out this statement.

It may be well to note that the values of the constant multipliers of p in the two formulæ given above, that is, the values of the mean rate of change of density with concentration, throughout concentration ranges of from zero to about 2.5 per cent., in the case of these salts, are approximately the same. They are also approximately the same* as the same rates of change in the case of zinc and magnesium sulphates, and not very different from those of iron, cadmium, copper, aluminium and other sulphates.

* Trans. Roy. Soc. Can., Vol. VII, (1889), Sec. iii, p. 31.

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THE

PROCEEDINGS AND TRANSACTIONS

OF THE

Nova Scotian Institute of Science.

HALIFAX, NOVA SCOTIA.

SESSION OF 1891-92.

SECOND SERIES.

VOLUME I. PART 2.

The First Series consisted of the Seven Volumes of the Proceedings and Transactions of the Nova Scotian Institute of Natural Science.

HALIFAX, N. S.:
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1892.

CONTENTS.

PROCEEDINGS

OF THE

Nova Scotian Institute of Science.

SESSION OF 1891-2.

ANNUAL BUSINESS MEETING.

Halifax, 9th November, 1891.

PROF. J. G. MACGREGOR, *President, in the chair.*

The minutes of the last annual meeting were read and approved.

The PRESIDENT addressed the Institute as follows :—

Gentlemen,—In opening the proceedings of the present session of the Institute, the thirtieth, by a short review of the events of the year which has just ended, I feel a profound regret, which I know you will all share, in the fact that it is necessary to record the loss of one of our oldest members, Thomas Beamish Akins, D. C. L., who died on the 6th of May, 1891. Dr. Akins was born on the 1st of February, 1809. From 1857 until his death he held the office of Commissioner of Public Records in Nova Scotia, an office which gave him excellent opportunities of research in his favorite subject, Canadian and especially Nova Scotian History. His publications are all historical in character and will doubtless have been referred to and described in the Proceedings of our sister society, the Nova Scotia Historical Society, of which he was one of the most active members. Though he claimed no special knowledge of science, he was always interested in its progress, and having tasted the pleasure of research himself he was especially interested in the encouragement of scientific research among his young fellow countrymen who had scientific tastes. It was that interest doubtless which led him to become a member of our Institute in 1873, and to continue a member during the rest of his life ; and those of you who enjoyed the privilege of his acquaintance, know well the stimulus which was communicated by his cheery words and kindly encouragement.

Although we have met with no other losses either through death or resignation,

our roll of membership has not lengthened to the extent which is desirable. I feel that we ourselves through our lack of enthusiasm are somewhat responsible for the deficiency of our progress in this respect. The Institute is ready to receive as members not only persons who are actively engaged in scientific research, but also all persons who are in any way interested in science; and there must be many such persons in the acquaintance circles of all our members who might be induced to come in and help us if we would only make sufficient effort to inform them of the privileges of membership.

The main reason of the slowness of our growth however, seems to me to be the lamentable smallness of the number of persons in our Province who have even the very little knowledge of science requisite as a basis of interest in its advancement, and to the necessarily greater lack of persons who are able to carry out even the simplest forms of research. That we have less than the usual proportion of such persons among our citizens is shown not only by the difficulty which we experience in securing active and even inactive members, but also by our almost total lack of circle-squarers, discoverers of the perpetual motion and scientific hobby-riders generally. That it is so very rare an occurrence for any of our citizens to claim to possess ability to create energy or to overturn the Newtonian philosophy, may possibly be due to the universal diffuaion of sound education, but it is more probably due to the general prevalence of scientific ignorance which compels the erratic souls among us to turn their energies in other directions.

For the fact, or what seems to me to be the fact, that our general scientific intelligence is at so low an ebb, we who are engaged in education must, I think, be held to be largely responsible. I have referred in addressing you on a former occasion, to the difficulties which our higher educational system, or want of system, throws in the way of the performance of original work by members of the staffs of our colleges. The present arrangements of our school system similarly make it difficult for our intermediate teachers to acquire scientific knowledge, and still more to acquire scientific power, and in consequence make it next to impossible for them to transmit such knowledge or insight to their pupils. And this arises from two causes. First, we do not provide them with anything like adequate means for the study of science. They are consequently led to qualify themselves on scientific subjects, for the most part by the mere reading of books, gaining therefore only a dead knowledge of facts and laws, and rarely acquiring a conception of science as an ever growing body of knowledge, whose growth may be promoted by the humblest of its votaries if only he learn to use his eyes and ears and hands and brain.

Secondly, we attach far too great relative importance to literary and linguistic acquirements on the part of our teachers and far too little to the attainment of scientific proficiency. The more ambitious of our teachers naturally aim at winning the highest grade of teachers' license; and the course of study by which this is secured is very largely linguistic and literary and only to a very small extent scientific, while the examinations by which it is tested are far more searching in the subject of languages, history, etc., than in the department of science. It follows that it pays a teacher to put his strength into Latin and History and Grammar. and to neglect scientific subjects; and the ambitious man usually does so.

It seems to me therefore, that two very beneficial changes might be made by those who have the direction of these matters,—first, the provision of better educational facilities in scientific subjects than we now possess, and secondly, the increase of the importance of scientific subjects relatively to the other subjects of the higher teachers' examinations. The complex character of our higher educational system renders the provision of improved facilities for scientific study, on any large scale, difficult, except by the slow process of educating the public. But while public opinion is being brought up to the point of expenditure, teachers might be led to use such facilities as we now possess more than they now do, by the second change referred to, For if scientific subjects were given a relatively greater importance in the requirements for license, and thorough knowledge which could not be acquired by the mere reading of text-books were demanded, this effect would be at once produced. I have elsewhere suggested that for this purpose two grades of teachers' license of the highest rank should be instituted, which might be roughly described as literary and scientific respectively, and which would differ from one another in the relative extent of the literary and scientific knowledge required. Were this course followed, the teacher of scientific tastes, could put his main strength into the study of science without running the risk of failure in applying for the highest grade of license ; and a body of teachers would thus be provided, able to carry out the wishes of School Boards whose members might have come to think that the thorough teaching of elementary science in our schools is a matter of great importance.

The effect of such a change on the work of our Institute is at once apparent. For not only would a body of teachers who had given their chief attention to scientific study, probably provide us with a number of active members, but the general diffusion of a knowledge of elementary science in the rising generation, would before long provide for us here and there men and women, who, whatever their main work might be, would for relaxation turn to the cultivation and advancement of some favorite branch of scientific study.

The need of change in our educational arrangements being thus apparent, I feel sure that I may congratulate the Institute on the fact of the appointment of its Corresponding Secretary to the important position of Superintendent of Education for Nova Scotia. Mr. MacKay is singularly well fitted for this position. For he is a man who distinguished himself in his University course, both in the literary and in the scientific department, having graduated both in Arts and in Science. His own tastes have led him in the direction of scientific research, and the special weakness of our schools in the department of science has led him to give much time and attention to means of securing improvement in this respect. We therefore have good ground for hope, that under his regime, sure progress in the diffusion of scientific knowledge will be made. On the other hand, however, the more conservative educationists, who have little confidence in science as a means of culture, have alse the satisfaction of knowing that he is an all-round man, with a literary as well as a scientific training, and unlikely, therefore, to exalt the latter at the expense of the former.

During the past year the Council has continued the extension, begun in the previous year, in the circulation of our publications. The last issue of the Proceedings and Transactions was sent to 594 Libraries and Scientific Institutions,

The majority of these are home and foreign Scientific Societies. But they include also, all Canadian Universities and Colleges, all Nova Scotian schools which have libraries, and all other Nova Scotian Libraries, of which we have knowledge. Of the Scientific Societies to which we are sending, about one half are already sending us their publications in return, so that the rapid growth of the Library to which I referred in addressing you last year, still continues.

The growth of our Library and the inconveniences of our present accommodation, which make access to our books extremely difficult, keep before our minds the necessity of some change in this respect. I regret to say that the effort, to which I referred last year as being made, to secure a building to accommodate the Provincial Museum, the Legislative Library, the City Library, the Art School, the Historical Society's library, and our own, has not resulted in success, and has had to be abandoned, at any rate, for a time. We, however, must make some new arrangement at an early date, if we are to avoid boxing up and storing in a temporarily inaccessible way, the publications which scientific societies are sending us; and the incoming Council cannot direct their efforts better than in an endeavour to secure a local habitation. I am firmly convinced the progress of the Institute is largely dependent upon its securing convenient rooms in which its meetings may be held and its members have easy access to the library. The main difficulty is of course, in the payment of the rent of rooms and the salary of a Librarian. At present the publication of the Transactions, the binding of books, and general miscellaneous expenses, use up our whole income, although the business of the Institute is so carefully managed that retrenchment seems impossible if its main work, the publication and circulation of its researches and the building up of its Library, is to be continued as at present. Possibly the annual expenditure necessary to secure convenient quarters may be considerably diminished by co-operation with the Historical Society, which, though more favorably situated than we are, nevertheless finds its work impeded through lack of accommodation. But in any case if a local habitation is to be secured, our income must be increased. Might I therefore suggest to the new Council that they should discuss the feasibility of what seems to me the only probable way of securing such addition to our income, viz., hiring rooms, appointing an Assistant Librarian to keep them open as many hours a day and as many days a week as may be found possible, subscribing for the leading scientific papers, throwing the Library open to the public on payment of a small annual fee, and then appealing to the public to assist us on the ground of the public utility of our action. To meet the expense incurred an active canvass would have to be made by our members. But there must be a large number of persons in the city especially, who would be willing to pay our small annual fee for the privileges which membership under the new conditions would bring, and many also who would be willing to become members in order to secure for the public the benefit which would be involved in aceess to our books.

Finally, before proceeding to the business of the evening, I wish to renew my thanks to the Institute for the honour they have done me in continuing my Presidency during the full term permitted by its laws. During my term of office, the Institute has met with serious reverses. But I think I may say that through the hearty co-operation of many of its members, it is now stronger, more active

in its work, and of greater public utility than ever before. From my own experience I can assure my successor that any efforts which he may put forth to forward the interests of the Institute will be warmly seconded and cordially appreciated.

The Treasurer presented his annual report, and Messrs. Bowman and Piers, having been appointed auditors, examined his statement and found it correct.

The following were elected officers for the ensuing year:—

President—M. MURPHY, D. Sc., C. E.
Vice-Presidents—H. S. POOLE, F. G. S., and PROFESSOR LAWSON, LL. D.
Treasurer—WM. C. SILVER.
Corresponding Secretary—A. H. MACKAY, B. A., B. Sc.
Recording Secretary—ALEXANDER MCKAY.
Curator of the Library—MAYNARD BOWMAN.

Councillors without office:—Professor J. G. MacGregor, John Somers, M. D., Principal O'Hearn, F. W. W. Doane, C. E., E. Gilpin, Jr., A. M., F. G. S., Augustus Allison, Harry Piers.

ORDINARY MEETING, Province Building, Halifax, 9th November, 1891.

The PRESIDENT *in the Chair.*

Inter alia.

A series of photographs of Fossils, presented by Sir Wm. Dawson, was exhibited.

A paper by T. C. Weston, of the Geological Survey of Canada, entitled: "Notes on Concretionary Structures in various rock formations in Canada," was read by Mr. A. H. MacKay, Superintendent of Education. (See Transactions, p. 137.)

ORDINARY MEETING, Province Building, Halifax, 14th December, 1891.

The PRESIDENT *in the Chair.*

Inter alia.

A paper, by the late Rev. Thos. McCulloch, D. D., first President of Dalhousie College, entitled:—List of Localities for Trap Minerals in Nova Scotia,—together with a letter from his son, Rev. Wm. McCulloch, D. D., of Truro, with reference to it, were read by Prof. G. Lawson. (See Transactions, p. 160.)

Professor G. Lawson read a paper entitled:—"Notes for a Flora of Nova Scotia, Part II."

ORDINARY MEETING, Province Building, Halifax, 11th January, 1892.

The PRESIDENT *in the Chair.*

Inter alia.

Mr. K. G. T. Webster, of Yarmouth, read a paper entitled:—"On the Fletcher Stone." (See Transactions, p. 208.)

A letter was read from R. B. Brown, Esq,, of Yarmouth, in reference to the Fletcher stone and other inscribed stones in Yarmouth County, N. S. In this letter Mr. Brown says:—

"The alleged discoverer of the Fletcher stone, Dr. Richard Fletcher, an Irishman by birth, and formerly a surgeon in the British army, settled in Yarmouth in 1809, and as he died in 1818, our first knowledge of it dates back to that period. Dr. Fletcher had it removed from the shore to a safe place near his residence to save it from mutilation, and there it remained for about 60 years, or until about 20 years ago, when it was brought round to the east side of the harbor, I believe, to have casts and photographs made from it. A contemporary of Dr. Fletcher was the late Dr. Henry Greggs Farish, whose son, Dr. G. J. Farish (also deceased), informed me that his father had taken him, when a lad of 15 years, to see this curiously marked rock. It will thus be seen that at least 80 years ago the stone with its mysterious writing was regarded as genuine by men of studious habits and scientific attainments, notwithstanding their inability to give an interpretation of its meaning.

"The original position of the stone was within a few feet of high water mark and about 300 feet south of Salt Pond dyke. A large boulder of quartzite weighing at least 20 tons, stands near the spot; and on the south side of this boulder is a cavity from which, without doubt, the Fletcher stone was thrown off, probably by the frost. If Mr. H. Phillips' interpretation of the inscription is correct —"Haka's son addressed the men"—Haka's son may have done so from the summit of this boulder. There is no other rock immediately near it, and the point of land on which it lies is approachable at all times of tide. If the woods contained a savage foe, as they probably did about 1000 years ago, no better place could be chosen to prevent a surprise, with water on both flanks and in the rear.

"My first critical examination of the stone was made when I was about 17 years old. While engaged in making a careful drawing of it, to be submitted by my cousin, Mr. Lawrie of Glasgow, to one of the Scotch Antiquarian Societies, I noticed that at intervals in the glyphs *irregularly shaped thin scales and grains of quartz* of a glassy character had formed. It thus appeared that one of two things must have happened; either there were hard silicious spots or veins running through the rock,—a common quartzite—from which the softer parts of the cuttings had been eliminated by some erosive action of the elements, or a general decomposition of the large flat surface of the rock had occurred, followed by a slow atomic deposition of silex in the cuttings of the inscriptions, facilitated and hastened perhaps by the salt spray of the tide water near by, as it was occasionally blown upon it by the westerly winds. The difficult problem was thus suggested as to how many centuries would be required in order to produce the effect described.

"Many years after this I had some correspondence with the late Judge James, relative to this matter. In a letter now in my possession, dated August 2nd., 1879, he says that a copy of my original drawing which I had given him, he had sent to Robt. Morrow, Esq., and also, that a photo taken by the Historical Society had been sent to several learned societies, including the Antiquarian Society of Stockholm, though with what result I never learned.

"The Judge very kindly copied and enclosed to me a Runic alphabet, with accompanying remarks taken from Sir J. Lubbock's 'Prehistoric Times,' and although I found some of the characters on the Fletcher Stone precisely like some of the letters of this alphabet, the most of them had no counterpart there.

"On one occasion when visiting Yarmouth the late Judge desired me to aid him in getting a sight of the stone as he had never seen it. I had heard that it had been brought over to the East side of the Harbor, and was on Water Street in front of a ship-chandler's establishment, and there we found it on the sidewalk inclined against a building; I had some difficulty in recognizing it however, and for this reason,—*the glyphs had been painted black*. An archipelago of *spatters* embellished the stone. I was afterwards told that the letters had been cleaned out with an iron spike, and then painted with a marking brush and lampblack, so that the photographer might be able to make a better copy.

"To those who may be interested in the solving of the mystery that surrounds this stone I would recommend a perusal of the introductory chapter of the 'Sequel to Campbell's History of Yarmouth,' the talented editor of which, Geo. S. Brown, Esq., being a grandson of Dr. Fletcher, must have been familiar with its history from his early childhood.

"I have reason to believe that this Fletcher Stone is not the only one of the kind in the county, as I have heard of at least one other on which similar markings occur. About twenty years ago Capt. Leonard Weston, a retired shipmaster and a very intelligent and well read man, told me of the existence of a large rock, I think on the Chebogue River, promising me that if I would come over to Arcadia, where he lived, he would take me in a boat to see it in order that I might copy the inscription. I regret to say that I delayed going until it was too late to profit by Capt. Weston's guidance. Both his sons, Mr. Dennis Weston and Rev. Walter Weston, had heard their father speak of the stone; but neither of them could give me any information as to where it was or what was on it. The only clue I can give to the locality of the stone is Capt. Weston's remark 'that we were to go in a boat from near his residence at that time (20 years ago) and that less than an hour's rowing or sailing would take us to the spot, that the stone was a pretty large one, and that it was near the water.' This does not amount to much as a pointer, but restricts the area of search to a radius of four or five miles and throws out of the question the whole west side of the river which could be approached without a boat. A search for it would occupy some three or four days and would involve the circumnavigation of a few islands and a visit to the site of an old Acadian village on what is called the Clements Farm.

"About sixteen years ago Mr. Louis B. D'Entrement in ploughing on his land at West Pubnico, Yarmouth Co., uncovered a stone on which was cut the figure of a leaping moose. The face of this stone was about 12x15 inches in diameter,

while its depth was at least 9 inches in the thickest part and rounded on the bottom, being evidently part of a beach-stone. It weighed about 200 pounds. The upper surface was nearly covered by an accurately drawn figure of a moose. The lines were very smoothly cut to a depth of from $\frac{1}{16}$ to $\frac{1}{8}$ of an inch. A careful examination of these lines through a magnifying glass showed none of that stippled appearance usual in inscriptions made on hard quartzites by means of a chisel or spike with sharp corners. I believe that only a flint implement could have been used with such effect. The stone was in my possession two days and was returned to the owner after I had made a plaster cast; and from a careful drawing of this cast I have made the accompanying pen and ink sketch.

"In 1877 when the stone was brought to me in Yarmouth, the owner stated that buried under the soil about 18 inches were several others variously marked, grouped around this one in circular form. The owner believing that they in some way were indicative of buried treasure declined to part with them.

"A few years later than the above date, I was fortunate enough to have a call from the late eminent Micmac scholar, Dr. Rand, who was so much interested in the above facts, that he made enquiries amongst the most intelligent Indians of his acquaintance, and on his next visit to Yarmouth informed me, that a legend existed amongst them to the effect that before the expulsion of the French Acadians back to a remote period, tribes of Indians met in council once a year on what is called Pubnico Point, but he could learn nothing as to the purposes of these conventions or as to their duration. The figures on some at least of these stones the Doctor regarded as *totems* or insignia of rank.

"Recently, at my request, Mr. Ryerson visited the old stores where the moose stone had been left, but we could find no trace of it. His clerk remembered seeing it at his office about a dozen years ago, but could not tell what had become of it."

A paper was read by M. Murphy, D. Sc., Provincial Engineer, President of the Institute, entitled : Supplementary notes on the destroyers of submerged wood in Nova Scotia. (See Transactions, p. 215.)

ORDINARY MEETING, Province Building, Halifax, 8th February, 1892.

The PRESIDENT *in the chair.*

Inter alia.

A paper by Mr. W. H. Prest, entitled :—Evidence of the Post-glacial Extension of the Southern coast of Nova Scotia, was read by the Secretary. (See Transactions, p. 143.)

ORDINARY MEETING, Provincial Museum, Halifax, 14th March, 1892.

The PRESIDENT *in the chair.*

Inter alia.

A paper entitled :—Nova Scotia Gold Districts, their Geological Formation, as proved by Borings in the Killag Gold District, by H. Squarebrigs McKay, was read by the Corresponding Secretary. The following are extracts from this paper :—

"My first visit to the district was spent in making a preliminary survey, noting the very large number of excavations made, some almost obliterated by time, while others showed, plainly, the diligent work of the prospector, without any particular method in his work. These excavations are mostly round pits, sunk in some instances to bed-rock, but in most cases not. The whole ninety-six mining areas are literally honey-combed with these excavations.

"In about the centre of the property, and covering an area of about thirty acres, is a depression in the formation where in some past age, there has been a lake, but which is now filled with sediment from the washings of the surrounding hills, till it is now a basin of quick-sand and mud, in places twenty-five feet deep, to bed-rock.

"This quick-sand prevented the prospector from carrying on his burrowing here, but it is surrounded to the very edge, with these excavations. In the centre of this sediment-filled lake, I found the mine which we had bought. It was filled with water.

"I found, by inquiry, that the top of the rock formation in the mine, was very much broken, but further down it was solid. This being the fact, it was perfectly clear what was best to do. I saw it was not necessary to drain the swamp, and that it was very necessary to see the mine in the shortest possible time, and for the smallest possible expense. From all the evidence I could procure, I was convinced that the geological formation of the district was not at all understood ; that I would, in all probability, make a total failure if I followed the advice of other people and did not make my own investigation, because from the investiga-

tions up to that time made, it was not possible for any one to know anything definite about the mine.

"Knowing all these facts, I commenced the investigation by building a coffer dam around the top of the shaft to keep out the water. This was done by building a frame-work round the shaft on the solid rock, 15 feet down on the inside, calking round this framework and between it and the rock, then sealing up the entire shaft from the frame-work to above high water mark, with grooved and tongued plank, leaving a space back of the plank, and between the plank and the rock, of about 8 inches, which was filled with Portland cement, after first calking all the cracks that could be found in the planking. When this cement hardened, —which it did in half an hour after being poured in, the seams in the rock and plank were perfectly filled with the cement; making it impossible for water to get through the plank and rock to the shaft, thus preventing any further trouble from surface water, all at a cost of one hundred and seventeen dollars and seven days' time.

"With this solution of the water problem, I was able at once to pump out the mine and set miners to work in the shaft and stopes, to expose the lode four feet in height and seventy feet in length. While this was being made ready I milled the ore that I found already mined and it yielded an average of 26 dwts. per ton. When the lode was exposed the entire length of the tunnel, four feet high, I commenced at the westerly end and crushed the ore as it was taken down, and I did not see one sight of gold in the quartz from the shaft, or the first thirty-six feet of the westerly end of the tunnel, it giving, in the mill test, but 1·2 dwt. to the ton; but at a point thirty-six feet east of the westerly side of the shaft along the stopes, the quartz showed good sights of gold, and from there to the end of the stopes, gave an average of 36 dwts. per ton. I carefully marked this line between the good ore and the poor, and repeated the test in the same manner farther down in the mine, finding this time 65 feet of the west end of the tunnel giving but 1 dwt. per ton, while the remaining 10 feet of the tunnel gave 26 dwts. per ton. This proved to my mind that the ore in the shaft and the westerly end of the tunnel was practically worthless, but at the extreme east of the mine was evidently good ore, and from this evidence it appeared that the mine was opened too far west to find the best ore. It was also evident that there was a 'pay chimney' and that it had a dip east, there being a large body of ore east and running out to a point about 20 feet west of the shaft. This line of dip I was able to obtain exactly by drawing a line from the point marked in the first test, between the good and poor ore, to the point marked on the last test, between the good and poor ore. This gave the 'pay chimney' dipping east at an angle of 40 degrees in the lode.

"A tunnel has now been driven 300 feet east on the lode in this 'pay-chimney' and from this tunnel has been taken, in all, 428 tons of quartz, which has yielded 493 ounces of gold or an average of 23 dwts. per ton, and the ore is as good in the extreme end of the tunnel, 300 feet east of the point of beginning as it was at the start. This 'pay chimney' is well defined and is dipping east, as above stated, at an angle of 40 degrees, containing ore worth 23 dwts. in gold per ton, while ore outside of it, west, contains but 1 dwt. per ton. This investigation proves the mine to have been open at least 400 feet west of the centre of the pay ore; and to have gone down with the shaft as originally opened, would have

proved a perfect failure. By opening the mine 400 feet east from where it was originally opened, and on what I now know to be 23 dwts. ore, it cannot but be a great success.

"While testing this lode, I have at the same time been making a careful survey of the entire district with a view of finding out the extent of the ore body in this district, with the exact geological formation of the rock.

"Former unsystematical prospecting, had been carried on in the drift, and sufficient return had been obtained to pay expenses of working for ten years in this way without one lode carrying gold being found. By further carefully surveying the facts, it is very evident some places are richer in gold from this drift, than others, and the richest of this comes within an area 500 feet north and south by 1,000 feet in length east and west, richer in the centre and grading off toward the ends ; and the whole area is 600 feet south of what I suppose to be the anticlinal of the formation. Also the description of the drift found, does not agree with that from the lode now worked, and this would evidently prove that there were richer lodes there than have yet been worked, and that with the proper systematic search, they could be found.

"Knowing where this rich drift had been found, it was clear that it came from the north, as the glacial throw of Nova Scotia is well known to be from north to south. The next thing necessary was to find the apex of the anticlinal, which, hitherto, has been unknown in the district. It is clear the glacial action has caused this drift to be carried south from the lodes in the folds of the strata forming the apex of the anticlinal. This is proved by my investigation, as will be seen by referring to my map. [The paper was illustrated by a detailed geological map of the district.]

"From surface indications and the rock formation, I was able to tell about where the centre of the fold of the anticlinal was. I had the surface soil removed from where it seemed to be, uncovering a space twenty-five feet long by twelve feet wide. This proved to uncover the rock exactly on the apex of the fold of the anticlinal with the lodes on the north side dipping north at an angle of 40 degrees, while those on the south were perpendicular and turning round on the east end, with a flap dip east. This proved the location of the anticlinal and the point of greatest erosion, and where there ought to be, from the evidence of twenty years' prospecting and the geological facts of the district, a great many quartz lodes. I then bored north and south with a diamond drill and found the number of lodes to be 52 in number, varying from one inch to three feet in width.

"The table on the following page gives their width and material with results of tests when made.

TABLE OF LEADS AND BELTS.

Lead.	Description.	Width.	Width and Material of Belts.
1	Not tested............	2 in..	From 1 to 2 is 6 ft.—slate.
2	"	½ " ..	" 2 " 3 " 2 " "
3	"	½ " ..	" 3 " A " 11 " "
A	Good base metals......	9 " ..	" A " 4 " 17 " —quartzite.
4	Not tested............	½ " ..	" 4 " 5 " 4 " "
5	"	7 " ..	" 5 " 6 " 2 " —slate.
6	"	10 " ..	" 6 " 7 " 8 "quartzite & slate.
7	"	9 " ..	" 7 " 8 " 5½ " "
8	"	2 " ..	" 8 " 9 " 4½ " —quartzite.
9	"	3 " ..	" 9 " 10 " 1½ " —slate.
10	"	4 " ..	" 10 " D " 4 in. - quartzite.
D	About 18 dwts. per ton.	18 " ..	" D " 11 " 17½ ft.—slate.
11	Open fissure	12 " ..	" 11 " 12 " 10 " —quartzite.
12	Not tested............	4 " ..	" 12 " 13 " 12¾ " "
13	"	2 " ..	" 13 " 14 " 5¼ " "
14	Open fissure	14 " ..	" 14 " 15 " 8 " "
15	Not tested............	2 " ..	" 15 " 16 " 4 " "
16	1½ oz. per ton	4 " ..	" 16 " S " 17 " —slate.
S	1 oz. per ton..........	14 " ..	" S " 17 " 8 " "
17	Not tested............	3 " ..	" 17 " 18 " 40 " —tunnel.
18	"	5 " ..	" 18 " 19 " 7 " —slate.
19	"	3 " ..	" 19 " 20 " 4½ " "
20	"	4 " ..	" 20 " 21 " 4¼ " "
21	"	6 " ..	" 21 " 22 " 4 " "
22	"	1 " ..	" 22 " 23 " 5 " "
23	"	½ " ..	" 23 " 24 " 1 " "
24	"	5 " ..	" 24 " 25 " 17 " "
25	"	½ " ..	

"The kind of rock with its width between the quartz lodes, will be of the greatest importance to us in our future work, as we will be able to estimate very closely, what the cost will be to cross-cut from one lode to another. And another important matter, is to be sure what will be reached by going in any given direction. It is not known how many lodes are outside of those given above, as that is the extent of the borings. I thought these enough to keep a mine running for a great many years, so did not go to the expense of boring further. Another important thing, in connection with the geological examinations, is the fact that in boring south, across the lode we were working, to see if it continued on, straight east, it was found it had shifted south 21 feet at a point three hundred feet east of the old Stuart shaft. This indicated a fault in the whole formation of the country, so I changed the diamond drill and bored at an angle of 90 degrees with the south boring and parallel with the lode, and strata, and discovered a quartz lode three feet wide, about 52 feet from the point of beginning. The strata were found to have been very much broken in the vicinity of this fault, showing the

tremendous strain that had been brought to bear, to fault the entire formation, and shatter the rock on either side of it. The core from the diamond drill showed all the base metals to be present in this cross lode, and every indication of its being a finely mineralized lode and one that can be expected to be a large producer of the precious metal. This cross lode is lying on a very flat dip east. About all the 52 lodes found, showed good base metal in the drill core, but as the core was only $\frac{7}{8}$ of an inch in diameter, there was not much chance of striking gold.

A paper entitled :—Notes on Nova Scotia Zoology, Part II, was read by Mr. Harry Piers. (See Transactions, p. 175.)

ORDINARY MEETING, Provincial Museum, 11th April, 1892.

The PRESIDENT *in the chair.*

Inter alia.

A paper entitled :—On the Graphic treatment of the Inertia of the Connecting Rod, was read by Prof. J. G. MacGregor. (See Transactions, p. 193.)

A paper entitled :—On the Nidification of the Winter Wren in Nova Scotia, was read by Mr. H. Piers. (See Transactions, p. 203.)

A paper by Henry M. Ami, M. A., entitled :—A Catalogue of Silurian Fossils of Arisaig, N. S,, was read by the Corresponding Secretary. (See Transactions, p. 185.)

A paper by Rev. A. C. Waghorne, entitled :—The Flora of Newfoundland, St. Pierre and Miquelon, was read by the Corresponding Secretary.

The Recording Secretary read a letter from Rev. M. Maury, D. D., of Waltham, Mass., Corresponding Member of the Institute, containing a suggestion as to the cause of the differences of colour in Granite rocks, as follows :—

"Visiting a pottery in the town of Keene, N.H., I was told of an establishment in which granite is *moulded* and made into tiles, building stones, ornamental pieces, &c., &c. The *moulding* of granite appearing to involve an incongruity, I wended my way toward the 'Keene Granite Terra Cotta and Tile Works' where I saw the mystery satisfactorily solved.

"An objection to granite as a building stone is the fact that it will not stand heat. Subjected to heat it loses its tenacity and becomes brittle. Of this property advantage is taken in the manufacture of moulded granite. Ten tons of the crude stone are placed at once in a kiln and heated with a wood fire—the process being altogether similar to the burning of lime. When taken from the kiln the granite will crumble. It is easily reduced to the condition of sand. The next features of the process are identical with those of the manufacture of tiles. The sand-like granite is intimately mixed in water with clay, pulverized felspar and silica, forming what the tilemaker knows as 'paste,' which closely resembles in

appearance a grey-colored mud. In this condition it can of course be passed into moulds, subjected to pressure and forced to assume the shape of any design. The moulds like those employed in the making of pottery are of plaster of Paris.

"At this stage in the process the scientific interest properly begins. If a portion the moulded mixture is allowed to dry it is as brittle as a cake of oatmeal. Placed, however, in a kiln it becomes not only as hard as natural granite but a great deal more tenacious. It is difficult to break it with a hammer. If the mass be as thick as an ordinary brick it will resist many heavy blows. The pressure which it will sustain is enormous. In addition to this it is stated that the application of water to the baked granite when hot will not cause it to crack. The chief owner of the works told me he had had one tile heated to redness on 14 successive days and placed while red hot in water. It was not cracked by any or all of these tests.

"But the process of making artificial granite does not simply illustrate the power of heat as a rock-making agency. It does this admirably. But there is another point of even greater interest, because I do not think it has ever before been suggested, though here I may of course be in error. What makes the difference between red granite and grey? The 'charges' drawn from the kilns of the Keene Artificial Granite Works answer this question. A difficulty not uncommon in the 'firing' of pottery and tiles has very naturally been encountered in the granite making process. It is not easy to secure uniformity of temperature in every part of the kiln. Hence arises lack of uniformity in the color of the bricks and blocks of artificial granite. The majority are, as they should be, grey, precisely resembling the natural granite, and to be distinguished from the natural stone only by close inspection; but some are pink and some are red. These colors are produced where the heat of the kiln has been most intense. I should like to offer to the Nova Scotian Institute for their consideration and discussion the suggestion based upon this fact—that the color of pink and red granites is to be referred to the greater intensity of heat to which in the unequally heated kilns of nature, they have been subjected—in other words that they are superheated grey granites."

ORDINARY MEETING, Province Building, 9th May, 1892.

The PRESIDENT *in the Chair.*

Inter alia.

A paper by Mr. A. Cameron, Principal of Yarmouth Academy, entitled :—On the visibility of Venus to the naked eye, was read by Prof. J. G. MacGregor. (See Transactions, p. 148.)

A paper entitled :—The Geology of Cape Breton :—the Lower Silurian, was read by E. Gilpin, Jr., A. M., F. G. S. (See Transactions, p. 167.)

ALEXANDER MCKAY,
Recording Secretary.

LIST OF MEMBERS

ADMITTED TO THE INSTITUTE DURING THE SESSION OF 1891-92.

(For former list, see p. XII., Part I.)

ORDINARY MEMBERS.

	DATE OF ADMISSION.
DesBrisay, A. E., C. E., Halifax	Jan. 4, 1891.
Donkin, H., C. E., Point Tupper, C. B.,	Nov. 30, 1892.
Hendry, W. A., Halifax	Jan. 4, 1892.
Irving, G. W. T., Halifax	Jan. 4, 1891.
Locke, T. J., A. B., Halifax	Jan. 4, 1892.
McColl, Roderick, C. E., Halifax	Jan. 4, 1892.
McKerron, Wm., Halifax	Nov. 30 1891.
Mackintosh, Kenneth, Halifax	Jan. 4, 1892.

CORRESPONDING MEMBERS.

Litton, Robt. T., F. G. S., etc., Sec. Geol. Soc. Aust., Melbourne, Australia	May 5, 1892.
Maury, Rev. M., D. D., Waltham, Mass.	Nov. 30, 1891.
Waghorne, Rev. A. C., New Harbour, N. F. L.	May 5, 1892.

LIST OF INSTITUTIONS TO WHICH COPIES OF PART I OF VOL. I OF SERIES 2 OF THE PROCEEDINGS AND TRANSACTIONS HAVE BEEN SENT.

The Intitutions mentioned on pp. XV.—XXX. (Part I), together with the following:—

Bath, G. B.—Natural History and Antiquarian Field Club.

Belgrade. Servia.—Academie Royale de Serbie.

Berlin, Germany.—Zeitschrift für den physikalischen und chemischen Unterricht.

Berne, Switzerland.—Société Geographique de Berne.

Besançon, France.—Société d' Horticulture du Doubs.

Boston, Mass.—Appalachian Mountain Club.

Boston, Mass.—New England Historic Genealogical Society.

Bournemouth, G. B.—Bournemouth Society of Natural Science.
Brisbane, Queensland.—The Queensland Museum.
Brisbane, Queensland.—Royal Geographical Society of Australia.
Brussels, Belgium.—Société Royale Belge de Geographie.
Buda-Pest, Austria-Hungary.—Société Hongroise de Geographie.
Centre Co., Pa.—Pennsylvania Experiment Station, State College.
Champaign, Ill.—Illinois Agricultural Experiment Station.
Columbus, Ohio.—Ohio Agricultural Experiment Station.
Demerara, British Guiana.—Royal Agricultural and Commercial Society.
Douai, France.—Union Geographique du Nord de la France.
Edinburgh, G. B.—Royal Scottish Arboricultural Society.
Eugene, Oregon.—The Oregon Naturalist.
Giessen, Germany.—Jahresbericht über die Fortschritte der Chemie.
Gotha, Germany.—Petermann's Mittheilungen.
Halifax, N. S.—Office of Superintendent of Education.
Hamburg, Germany—Geographische Gesellschaft.
Hannover, Germany.—Geographische Gesellschaft.
Heidelberg, Germany.—Universität.
Ithaca, N. Y.—Agricultural Experimental Station, Cornell University.
Kingston, Jamaica—The Botanical Department.
London, G. B.—Nature.
London, G. B.—Royal Agricultural Society of England.
London, G. B.—Royal Geographical Society.
London, G. B—Chemical News.
New Haven, Conn.—American Journal of Science.
Newport, Orleans Co., Vt.—Orleans County Society of Natural History.
New York, U. S. A.—Science.
New York, U. S. A.—Commissioners of Fisheries for the State of New York.
Paris, France.—Société de Geographie.
Rochester, N. Y.—Academy of Science.
Rochester, N. Y.—Geological Society of America.
Rouen, France.—Academie des Sciences et Belles Lettres.
St. Anthony Park, Minn.—Experiment Station of the College of Agriculture, University of Minnesota.
St. Petersburg, Russia.—Société Imperiale de Geographie.
Sydney, N. S. W.—Geographical Society of Australia.
Vienna, Austria-Hungary.—K. K. Geographische Gesellschaft.
Washington, D. C.—American Geographical Society.
Zurich, Switzerland.—Schweizerisches Polytechnikum.

TRANSACTIONS

OF THE

Nova Scotian Institute of Science.

SESSION OF 1891-92.

I.—NOTES ON CONCRETIONARY STRUCTURE IN VARIOUS ROCK FORMATIONS IN CANADA.—BY T. C. WESTON, OF THE GEOLOGICAL SURVEY OF CANADA.*

(*Read Nov. 9th, 1891.*)

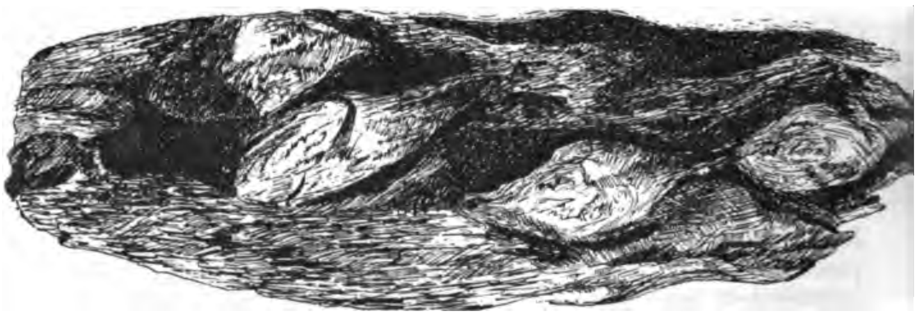
MANY times between the years 1860–70 the late Sir Wm. E. Logan, and subsequently Dr. Selwyn, called my attention to certain concretionary forms found in the gold-bearing rocks of Nova Scotia. Some of these seemed to be organic, and I was requested to make and examine microscopic sections of them. In treating several of these with acid, they proved to be composed chiefly of dolomite, with a large proportion of siliceous matter, and generally a little iron pyrites, which formed a nucleus.

In 1890 a number of similar forms were found by Mr. Willis in the rocks of the Northup Gold mines, Rawdon, Nova Scotia. They were handed to Professor Hind, who supposed them to be fossils, and assigned them to Lower Silurian age. Wishing the "judgment of a specialist," he gave them to Professor Kennedy, of King's College, who confirmed Professor Hind's opinion and pronounced the fossils to be *Stromatopora*. Mr. Fletcher and Mr. Faribault, of the Geological Survey, while in the vicinity

* Communicated by permission of the Director of the Geological Survey of Canada.

where this discovery was made, visited the mines, and brought away a number of these so-called fossils. They were given to me by Dr. Selwyn, director of the Dominion Geological Survey, for microscopic examination; and, I regret to say, the result is precisely the same as for those examined thirty years ago.

They appear to be composed of dolomite, and, when dissolved in hydrochloric acid, leave a good percentage of insoluble matter, probably felspar and silica. It is likely that they were spheroidal or ovoidal in form before being flattened by the pressure of overlying beds. One of the specimens before me is a piece of greenish-grey laminated mica-schist five inches long and one inch thick. Inclosed in this are four of these concretionary forms broken through the centre, each measuring one inch in length and half an inch in breadth. Two of these are connected with each other by a thin strip of the material of which they are composed.



DOLOMITIC CONCRETIONS IN GOLD-BEARING ROCKS OF NOVA SCOTIA.

In broken sections some of these bodies show slight concentric layers which in microscopic sections are not seen. Not a trace of organic structure was found.

I quite agree with Professors Hind and Kennedy as to the importance of finding fossils in the auriferous rocks of Nova Scotia, and trust they have been more fortunate than I

It is well known that concretions occur in all rock formations. One or two instances will be worth recording to show how care-

ful one should be in referring any forms of a concretionary nature to organic structure.

About the year 1863, forms with a decided concretionary aspect were found in the Huronian rocks of St. John's, Newfoundland. (The label on the specimen now in the geological museum, Ottawa, gives the exact locality, but not the date.) They were at once pronounced to be fossils, and even referred to the genus *Oldhamia*, having a slight resemblance to *O. radiata* of the Cambrian rocks of Ireland. A number of pieces of green argillite with these markings were sent to Sir Wm. Logan for examination. I was instructed to slice and examine them with the microscope, but before doing so ventured to tell Sir William that they were only concretions, and that, moreover, they lay transverse to the bedding of the rock. He was much vexed and showed a long paragraph about them which had appeared in one of the Newfoundland papers. Much to the disappointment of the discoverer of these supposed wonderful fossils, they were only concretions.

CONCRETIONS IN HURONIAN ROCKS OF NEWFOUNDLAND.

Similar forms can be seen in the Potsdam rocks on the coast of Labrador, and in the red slates and argillites on some of the small islands in the St Lawrence River.

In 1870 Dr. Selwyn found in the grey auriferous slates at the Ovens Bluffs in Lunenburg County, Nova Scotia, certain fucoidal markings which Mr. Billings, palæontologist to the Geological Survey, regarded as belonging to the genus *Eophyton* (Geological

TREE-LIKE CONCRETIONS AT KINGSTON, ONT.

Survey Report, 1870-71, page 269). Mr. G. F. Matthew describes similar markings from the Cambrian rocks of St. John, N. B., as being produced by some animal (Trans. Roy. Soc. Canada, Vol. III., page 150). The Ovens specimens he refers doubtfully to the genus *Ctenichnites*. But, whether they are plants or tracks,

it is an interesting discovery which should urge those working among the gold-bearing slates of Nova Scotia to a diligent search for organic forms.

At Dr. Selwyn's request, the writer spent several weeks among the gold-bearing slates of St. Mary River, the Ovens, and other localities in Nova Scotia. At Cape St. Mary, concretionary forms such as those from the Northup mines, only very much flattened, some to the eighth of an inch in thickness, were seen. Many were broken open and carefully examined, but no trace of organic structure was found.

In the Cambrian sandstones (Potsdam), on the banks of the Rideau Canal, near Kingston, Ont., large cylindrical trunk-like

SECTION OF WEATHERED SPECIMEN.

concretions stand erect transverse to the bedding of the deposit. Some of these are from ten to twenty feet in height. (See figure, p. 140.) Dr. Selwyn visited these so-called fossil trees, and

caused a section of one four feet in diameter to be sent to the museum in Ottawa.

The writer also saw these singular bodies, and assisted in getting good photographs of them. Weathered transverse sections show well-defined concentric rings of various colors, measuring from the eighth of an inch to three inches in thickness, but there are no radial lines. (See figure, p. 141.) The people in the vicinity of the quarries where these trunk-like forms are found were much disappointed when told by Dr. Selwyn that they were only concretions.

On the other hand, many of the fossils found in the Chazy and Trenton formations of Ottawa were at one time supposed to be concretions, but are now known to belong to the family of the *Monticuliporidæ* (Micro-Palæontology, by Arthur H. Foord, page 24, plate VI.). It is, therefore, important that all such nodular or concretionary-looking forms from the auriferous slates of Nova Scotia should be microscopically examined before coming to the conclusion that they are organic remains, and especially before assigning names to what on thorough examination turns out to be of inorganic origin.

II.—Evidence of the Post-glacial Extension of the Southern Coast of Nova Scotia.—By W. H. Prest.

(Read Feb. 8th, 1892.)

At various points on our southern coast are deposits of peat and marsh mud below high water mark. These often contain roots and stumps of trees now existing in this Province, and, by their position and by other circumstances, point conclusively to a late subsidence of the land.

Similar deposits have been referred to by geologists as existing on the coast of Cumberland County, and the same conclusion has been drawn from their occurrence there. I will here give further evidence which may be of value in future investigations.

Below Black Point, at the mouth of the Liverpool River, Queens County, is a deposit of black mud containing roots of bushes. In some places the mud, nearly one foot thick, has been washed away by the force of the waves, disclosing the angular rocks beneath, which show no appearance of ever having been part of a sea beach. The marsh has now a covering of sea shells, and is daily washed by the tides.

On the coast at Black Rocks, south-east of Lunenburg, is another deposit of peat and mud containing tree stumps and roots. This peat bed is situated in a deep gulch or valley at the head of a cove, and is several feet deep. It is underlaid on each side of the gulch by what is probably a beach of sand and gravel, and overlaid by a slight deposit of sand and sea shells. Whether the underlying beach is of marine or fluviatile origin I am not prepared to say, but the surface of the peat is washed daily by the tides. The following section will fairly illustrate the subject:

Section—
1. Cambrian slates.
2. Sand and gravel.
3. Peat and mud, containing tree stumps.

That these stumps have grown where they are now embedded is indisputable, as they cannot possibly be accounted for by a land-slide. The contour of the neighbouring surface is totally opposed to it. The valley is surrounded by cliffs and rocky hill-sides, and contracts at its upper end into a narrow rocky gulch, so that the present position of the stumps is the only place where vegetation could have thriven and peat have been formed. The stumps are much decayed and worn level with the surface of the bog, but are still complete enough to show that they are indigenous to this spot.

At the mouth of Broad River, in Queens County, behind a sand bank, is a large depression which at low tide is a marsh containing a pond one quarter of a mile long. At high tide it is a lake. The oldest settlers say that sixty years ago, this place was a swamp covered with forest. The partly decayed stumps and roots now found at low tide attest to the truth of the story.

At Catherine River, east of Port Joli, in the same County, a large tract of salt marsh was dyked, and a new river channel cut. This channel, although cut through soil periodically covered by the tides, reveals several feet below the surface abundance of partly decayed roots, stumps and logs. The existence of a forest at this place seems to be beyond the memory of the oldest inhabitant and I have failed to secure any tradition relating to it.

At Port Mouton, also, as well as other places around our coasts, deposits of peat containing logs, roots and stumps are seen at low tide.

In Prince Edward Island, a short distance above the city of Charlottetown, there is to be seen at low tide a considerable deposit of peat and marsh mud containing the stumps and roots of immense trees larger than any I have ever seen on the Island. These stumps have been worn down and are gradually becoming covered with sand.

On the south shore of Cascumpec Bay is a vast bed of peat known as "Black Bank." It is the result of the growth of a species of peat moss denominated "Sphagnum." The contents of this bog have been estimated at 14,080,000 cubic yards. With

it is seen the usual accompaniment of tree roots, some of which are in a perfect state of preservation. One layer of roots is seen below low water mark. A section of this bog twelve feet high is exposed on a point, and, even at that height, the waves during storms reach its very top. The decrease in size of this bog must already have been considerable, as it is well known that the deposits are thin at the edges.

A like deposit, but of far less extent, is seen at Lennox or Indian Island in Richmond Bay. It is supposed to have an average depth of seven feet, and the tide reaches within three feet of the top. At low tide stumps and roots are seen here as elsewhere.

At Gallas Point and other places in Orwell Bay, tree stumps apparently rooted in the marshes in which they grew, are seen five feet below high water mark. Those accumulations, once, undoubtedly, on a much higher level have been recently submerged, so that the sea is continually working upon them.

The above details are, I believe, entered in a published report on the Geology of Prince Edward Island. I mention this to show that in the neighbouring Provinces also a gradual subsidence is now going on. There are, undoubtedly, numerous other places along our coasts where it is apparent that peat bogs and forests are being slowly engulfed by the ever-advancing sea. A summary of this class of evidence seems to show that there has been a very recent (geologically speaking) subsidence of the Maritime Provinces. This subsidence must have been at least eight or ten feet, for in order to protect and promote the growth of vegetation, the surface must not only be above the highest tides, but must be beyond the reach of the sand and stones thrown up by storms, especially in an exposed situation like Black Point. Unfortunately we have no means of determining the time in the case of subsidence as we have in the case of elevation, all evidence being swallowed by the ever-restless sea.

At Musquodoboit Harbor, Halifax Co. when the tide is low and the water placid, is seen a deep and narrow channel extending through the surrounding flats to the sea. This channel is walled with cliffs of solid rock in some places almost perpen-

dicular, and may be seen at various places throughout the Harbour. At the head of the Harbour where the Musquodoboit River enters, the channel is extended by a like depression and steeply escarped rocks. This last is seemingly a simple continuation of the defile below, and a glance at the steep parapets a short distance above tells the story of its formation. Like Niagara, it has been apparently for many thousands of years subject to the undermining and eroding influences of the swiftly flowing river. Ages ago after the last recession of the continental ice fields it probably began its work, which resulted in the present almost perpendicular cliffs, and ages hence should the same influences be still at work, time, if not man, will witness the retreat of the steep rapids and their present position occupied by a deep defile resembling the one below.

The formation of this river gorge, I have ascribed to what seems to me the most efficient and probable cause, supported by similar evidence on the LaHave, East, Sutherland and numerous other rivers. That it was formed since the glacial age, the cliff tops glaciated to the edges which are yet angular and unworn, seem to prove. That it was not formed by the sea is evinced by its tortuous course through the surrounding hills, preventing the possibility of powerful action at the foot of the cliffs. That it is not an enlarged fissure is demonstrated by the undisturbed state of the slate and quartzite strata through which it is cut. Thus we are left to accept the formative influences first detailed as the most reasonable and effective cause of its conformation.

Now to apply this argument where it rightfully belongs I may say that the Harbour channel is an exact counterpart in almost every particular of the river channel. Its surroundings, tortuous course, conformation and geological structure are the same, but while the harbour channel is fringed with water-covered mud and sand flats, the river flows through dry land. However, the inference forced upon us seems to be the same, viz., that the harbour channel was excavated by the river at a time when the land was at least thirty feet higher, and the mouth of the river seven miles farther south than it is at present. To pursue the subject still further some credence may perhaps

be given to the theory that the granite boulder dredged by the Challenger one hundred miles off the coast denotes the extension of glaciers and consequent existence of land that much farther south.

Speculations regarding the time when this doubtful southern extension of glaciers took place might not be altogether futile if we only knew the rate of deposition on that part of the sea bottom. No doubt the above mentioned boulder was on the surface or within a few inches of the surface of the mud or clay composing the bottom, and the inference drawn from these facts will be, that either the annual deposition is inconceivably small or that the boulder was dropped from a passing iceberg long subsequent to the great ice age.

As to the time when the Musquodoboit River began to excavate its channel, an approximate estimate might be made, provid- the rate of erosion were known. The rock is a hard quartzite and slate, and with only the now existing denuding agencies its excavation would be a work of many thousand years. To take Sir Charles Lyell's calculations for the much softer rocks of the Niagara, which is I think 33,000 years, we may arrive at a very rough approximation. But as his figures have been often disputed, we must rest content in the belief that many thousand years ago our sea coast extended much further south, and that had it remained so, Halifax would never have been the chief Naval Port of the British North American squadron.

Art. III.—On the Visibility of Venus to the Naked Eye.—By Principal A. Cameron, Yarmouth.

(Read May 9th, 1892.)

Astronomers tell us that Venus is always visible through the telescope. Not always from any one station on the earth's surface, because of course she cannot be seen when below the horizon; but always from somewhere on the earth, and always from any given place while she is above the horizon of that place and in a clear sky. When these two conditions are satisfied the telescope will show Venus whether the time be noon or night and whether the planet be at greatest elongation or at either conjunction—barring only those rare occasions when she passes directly behind the sun at superior conjunction.

So, if one has a telescope, he may see Venus every day in the year,—weather permitting of course, which is a very important practical consideration and must always be so in such matters until our meteorologists get the whip hand of the weather fiend and make him keep his clouds out of the way. If, however, one has no telescope, nor any other optical instrument except the naked eye, on how many days of the year may he see Venus? This is a question which every star-gazer finds himself asking at times; and closely connected with it is this other one,—When and for how long a period can Venus be seen in the day time with the naked eye?

These questions form the subject of this paper, which may be described as a contribution towards procuring answers to them. When I first became interested in them I sought for answers in the pages of astronomical books and periodicals and by sending letters of inquiry to astronomers, but these methods of research proved fruitless. Then I applied to Venus herself, and jotted down the bits of information which from time to time she was kind enough to give me. After I had been at this for a year or two I learned that M. Bruguiere of Marseilles had been engaged

on the very same work for several years and had made and recorded a large number of observations. These he was good enough to send me, and in this paper I have made use of them as well as of my own and of any others that I have been able to lay hands on.

As seen from the earth, Venus completes a revolution around the sun in 584 days. During one half of this time she is evening star, and during the other half morning star. By way of a few preliminary and explanatory remarks, let us consider her motion and the various changes she undergoes during the 292 days of her season as evening star, and for the sake of simplicity let us suppose that both she and the earth are at their mean distances from the sun. Both orbits differ but very little from circles, and the results got from considering only the mean distance will be quite correct enough for the present purpose.

At the beginning of an evening star season Venus is in superior conjunction on the further side of the sun from us, and is in the same part of the sky as the sun is. She cannot then be seen by day because she is hidden in the sun's rays, and she cannot be seen in the evening because she sets at sunset. After superior conjunction she moves off to the east of the sun. In 39 days she is 10° away, in 78 days 20°, in 120 days 30°, in 166 days 40°, and 220 days after superior conjunction she reaches her greatest elongation of 46° 20.′ Only 72 days are left for her to get back, less than a third of the time she takes to swing out. Half of the 72 days are used up in working back to 40°, 14 days more to 30°, 9 days more to 20°, and in another 13 days she is again in line with the sun, this time on the hither side of him and in inferior conjunction. In so far then as her visibility depends on her elongation, it is apparent that she can be seen at a shorter interval of time from inferior than from superior conjunction. It is always perfectly easy to see her when 20° out, and if this were the limit of her visibility we would have to wait 78 days after superior conjunction before getting a glimpse of her, but we could see her every evening after that until 13 days before inferior conjunction.

While her elongation is changing, her brilliancy is changing also. At greatest elongation she is three times as bright as at superior conjunction. This does not mean that it is only three times as easy to see her in the former position as in the latter—it is infinitely more easy to do so. No eye can see her in the one case, and no eye can fail to see her in the other. What is called brilliancy is a something quite independent of elongation, and it is lack of elongation and no lack of brilliancy that makes Venus invisible at superior conjunction. If, when at superior conjunction, she had the brilliancy which she has at greatest elongation, she would still be invisible to the naked eye; and if, when at greatest elongation, she had only the brilliancy of superior conjunction, she would still be the brightest gem in the sky.

The actual brilliancy at any moment depends on several conditions, some physical and others geometrical. Of the physical conditions we know too little to be able to make them the subjects of calculation; but from the geometrical conditions we can calculate the relative theoretical brilliancy for any position in her orbit, and this is found to agree quite well, as a general rule, with the actual observed brilliancy. These geometrical conditions are three in number: the distance of the planet from the sun, the distance of the planet from the earth, and the phase of the planet—that is, the illuminated part of its disc. To get a general idea of the changes in Venus's brilliancy, we may, as before, suppose her to be always at her mean distance from the sun, and then the changes will depend only on her distance from the earth and her phase. It will be convenient also to select some standard in terms of which to express her different brilliancies. For this I shall take her greatest brilliancy as it always would be if both she and the earth were always at their mean distances and if the reflective powers of all parts of the surface of Venus were equal and constant, and I shall use the number 100 as the value of this mean greatest brilliancy.

At superior conjunction she presents the same face to the earth as she does to the sun, so that the value of her phase is 1—she is "full," as we say of the moon. But her distance from

the earth is then so much greater than when she is brightest that her brilliancy is only 24. As she moves out from superior conjunction her distance decreases, and so does her phase; but the increase of brilliancy due to the decrease of distance is greater than the decrease of brilliancy due to the lessening phase, and so she grows gradually brighter. When she reaches greatest elongation, her distance is only $\sqrt{\frac{1}{6}}$ of what it was at superior conjunction; and as brilliancy varies inversely as the square of the distance, it would now be six times what it was at superior conjunction if the phase remained full. But at greatest elongation the phase is only $\frac{1}{2}$—Venus looks now like a half moon in the telescope—and so the brilliancy is only three times as great as at superior conjunction; more precisely, the value in terms of our standard is now 73.

Not 100 yet, for Venus is not brightest when she is farthest from the sun in the sky. For five weeks after she begins her inward swing her brightness continues to increase and reaches its maximum value of 100 when she gets back to elongation 40.° This happens 256 days after superior conjunction and only 36 days before inferior conjunction, and when the phase is just about $\frac{1}{4}$. The decrease of brilliancy due to the lessening phase is henceforth greater than the increase due to the shortening distance, and the brilliancy goes down, and at a much swifter rate than it went up. In 16 days it goes down to where it was at greatest elongation; in 12 days more it is down to where it was at superior conjunction. Thus in the 27 days after greatest brilliancy Venus loses all the increase she gained in the 256 days before. Nine days later she is at inferior conjunction, and phase and brilliancy are each 0. This last statement is strictly true only when she makes a transit across the sun's face; at all other inferior conjunctions she appears in the telescope as a very thin crescent,—a mere thread of light—a little north or south of the sun.

Besides elongation and brilliancy, there is one other condition that affects the visibility of Venus, viz., her declination. In northern latitudes the farther north she is, the higher she rises, and the easier it is to see her in daylight. For observation in

the evening about the time that the other conditions are beginning or ceasing to be favorable, it is not so much her absolute declination that is important as the difference between hers and that of the sun. The longer the interval of time between sunset and the setting of Venus, the easier it is to pick her up at these critical seasons; and the length of this interval depends not only on the elongation, but also on this difference of declination. When Venus is farther north than the sun the interval is longer than that due to elongation, and when farther south it is shorter. When the elongation is 15° and the declination of both objects is 0°, the planet will set an hour after sunset; but if her declination were then 5° north she would remain above the horizon in this latitude a quarter of an hour longer, if 5° south a quarter of an hour shorter.

All of the above is just as true for the morning star season as for the evening star season if allowance be made for the fact that in the former case the season begins with inferior conjunction and ends with superior conjunction, instead of *vice versa* as in the case considered.

And now to answer the questions which form the subject of my paper, so far as the observations in hand admit of their being answered. In giving the particulars of elongation, brilliancy, etc., in connection with the observations, the hypothesis of mean distances used in the above prefatory matter is no longer retained. The actual distances of both Earth and Venus for each date, as given in the Nautical Almanac, are the ones that have been used. In the matter of brilliancy the same standard is used as above, and each value given is a percentage of the mean greatest brilliancy. All hours mentioned in the paper are standard time of the 60th meridian W. Long.

I have said that it is always perfectly easy to see Venus with the naked eye when her elongation from the sun is equal to or greater than 20°, and that this happens on the average at an interval of 78 days from superior conjunction and 13 days from

inferior conjunction. If this were the limit of eye-visibility there would be 91 days out of every 292 during which she would be invisible, and 200 during which she would be visible. If then there are any eyes so poor that they can't see Venus when nearer than 20° to the sun, even those eyes can see her for more than two-thirds of the time, that is for eight months out of every twelve on the average.

I have no particular reason for selecting 20° elongation as the upper limit of perfectly easy visibility except that 20 is a nice round number, and that something of this sort may be found convenient to refer to afterwards. As to the "perfectly easy" character affirmed of Venus in this position, that is a matter that every one can verify for himself. The first opportunity to do so will occur on the evening of June 25, and the next on the morning of July 22 this year. On these dates Venus will be 20° out from inferior conjunction. This is the easier of the two 20° positions. In general the phase is then only $\frac{6}{100}$ but the brilliancy is 45. At 20° from superior conjunction the phase is, in general, $\frac{94}{100}$, but the brilliancy is only 27. The first opportunity for an observation of this last kind will occur on the morning of February 10, and the next on the evening of July 14, 1893.

Our business now is to see how much nearer to conjnnction than 20° the naked eye can see Venus, and at how small a phase and how low a brilliancy.

I shall take up the observations near superior conjunction first.

In 1888 Venus was in superior conjunction on July 11. About a month later I began trying to pick her out in the sunset sky, but the weather was against me and it was August 23 before I got the first glimpse of her. That was 43 days after conjunction. The elongation was then 12¼°, the phase $\frac{98}{100}$, and the brilliancy 24.4. The observation was made at 7.30 p.m., 15 minutes after the sun had dropped below the sea-horizon and when Venus was 3° above it. I learned afterwards that M. Bruguiere had seen her at Marseilles on August 12. This was only 32 days after

conjunction, when the elongation was 9°, the phase $\frac{99}{100}$ and the brilliancy 24.

Here we are already well within the 20° and 78-day limit, even with my 43-day and 12° observation, to say nothing of M. Bruguiere's still better one. As to mine, it was easy enough to make, any one might have made it if he had happened to be looking that way at that time. It was the result of a mere random search, for I had not prepared myself by any previous observations of sun or stars to know the exact spot in my sky where Venus would be at the time. I felt sure that the 43 days and the 12° could be cut down considerably, but I had to wait a year and a half before there was another chance to try.

The next superior conjunction occurred in 1890 on February 18 at 7 a.m. There is, of course, an opportunity *before* as well as *after* each conjunction to try how close to conjunction one can push his observations, and, if other things were equal, the before one would be the better of the two; for the observer would have each day's observation to help him in making that of next day. But other things are not equal. It is not that there is any difference in the astronomical or other conditions of the thing observed, the difference arises from the personal habits of the observer. Observations of Venus before superior conjunction have to be made in the morning before sunrise; after superior conjunction, in the evening after sunset; and under the social conditions of modern life the latter can be made much more conveniently and comfortably than the former. Some time or other —perhaps before next superior conjunction in the spring of 1893 —I may make up my mind (and my body) to try what can be done by morning observations, but I have nothing of that sort as yet that is worth recording in the present connection. And M. Bruguiere seems to be in much the same condition. The best observation made before superior conjunction that I find in his list is that of December 15, 1889, 65 days before the conjunction of February 18, 1890.

Three weeks after this conjunction, on March 10, I made my first attempt to catch Venus in the evening, but did not succeed. The next five days were cloudy. But the next (March 16) was

clear, and, having determined by a sun-observation that about 10 minutes after sunset Venus should be close to a certain chimney on a neighbouring house, I looked there at that time and saw her. A note made at the time says, "6.30 sun's centre in horizon, 6.42 Venus distinctly with eye." This was 26½ days after superior conjunction, the elongation was 6½°, the phase $\frac{90}{100}$, the brillliancy 24. This is the best observation I know of near superior conjunction, and is the best near either conjunction so far as smallness of elongation is concerned. It might have been even better, had it not been for the cloudy evenings on the previous five days. At Marseilles the weather was much worse than here, and it was not until two months later that M. Bruguiere got his first eye-glimpse of Venus after this superior conjunction.

The next one, and the last one to date, occurred at noon on September 18, 1891. The earliest observation after it that I have heard of was made by Miss Beatrice Tooker of Yarmouth on October 17, 29 days after conjunction; but this was with an opera-glass and so we can't count it here. The declination conditions were not as favorable for early eye-observations as on the previous occasion, and my eyes were not in good condition at the time for looking into a sunset sky. As a matter of fact I did not look for Venus at all until the evening of November 9, 52 days after conjunction, and by that time of course she showed up at once, and only five minutes after the sun's upper limb had disappeared below the horizon.

There is quite enough evidence here, I think, to show that our provisional limit of 20° and 78 days can be reduced a good deal. It would perhaps be going too far to say, on the faith of my observation of March 16, 1890, that we can always see Venus in clear weather when only 26 days and 6° out from superior conjunction; and yet that observation was the only one of mine, made near this conjunction, that gave Venus a fair chance to show what she could really do for us in this line. To be quite safe, however, let us allow a liberal margin of 50 per cent. or so to cover adverse declination conditions, and we shall have as

a general limit near superior conjunction an interval of 40 days and an elongation of 10°. Thus no one who wishes to have a daily glimpse of Venus need wait longer than 40 days after superior conjunction to begin having it, and in favorable conditions he may hope to be able to begin as early perhaps as 20 days after. Having once begun, the daily glimpse may be continued, weather permitting, for the next eight months or more, until Venus gets near inferior conjunction.

Nearer than 13 days certainly, for that is the interval of time that corresponds here to an elongation of 20°; and we have already found this elongation to be quite unnecessarily large in the case of superior conjunction, although there the brilliancy is only $\frac{3}{5}$ of what it is at 20° out from inferior conjunction.

Let us now see how near to inferior conjunction the observations at hand show that Venus can be seen.

Owing to several unfortunate circumstances I have never been able to do justice to Venus near any of these conjunctions. Before them, the sky has been cloudy or the early evenings have been required for other engagements; after them, the early mornings have been passed in the unconscious condition and the horizontal position common to most of us at those hours. As will be seen presently, this last unfortunate circumstance seems to have affected other observers as well as myself, and to it may be largely attributed the fact that there are no observations as near to inferior conjunction *after* it as there are *before* it. Then there is the other disadvantage already mentioned in connectien with observations made after superior conjunction; at such a time the observer has no previous day's observation of the same object to help him in selecting the right spot in the sky to look at. He can get over this of course by taking observations of stars having the same declination and the same hour-angle as the planet to be observed, but there still remains the other disadvantage of the inconvenient and uncomfortable hour at which planets must be caught early after passing to the west side of the sun.

The only observation of mine after inferior conjunction that I have kept a record of was made after an interval of 18½ days

when Venus was 26° out from the sun. It would be absurd to accept this as anything like a limit of visibility for this position. The observation was made at mid-day, and it was a purely random one to boot—not a bit of preparation had been made for it. Venus was then so bright as to be readily seen by a couple of friends who were prepared a minute before to swear that it was utterly impossible to see her with the naked eye at such a time. The date was May 19, 1889.

M. Bruguiere saw her two days earlier, on May 17, and his was probably also a midday observation. After the next inferior conjunction on December 4, 1890, he cut his own record down two days by seeing her on December 18 when she was 14 days out. I don't know at what time of the day this observation was made, but I would not be at all surprised to learn that it too was a noon one.

Nothing less than 13 days yet, and perhaps it may be thought that it was too rash to pooh-pooh that interval as unnecessarily large for this position. The mere absence of observations made at uncomfortably early hours would not, however, prove that they could not be made; but it fortunately happens that there is no need to urge this plea. December 13, 1890, was the ninth day after the last inferior conjunction. Half an hour before sunrise on that morning Venus was seen with the naked eye by Miss Katharine Travis, of Hampton, N. B. The elongation was then 15°, the phase $\frac{3}{100}$, and the brilliancy 28. This is the best observation I know of after inferior conjunction. I hope some of our early-rising star-gazers will better it after the next one on July 9 this year.

Much better has been done at the more convenient season before inferior conjunction. But not by me. My best observation of this kind was made 8 days before the conjunction of April 30, 1889, on the evening of the 22nd. The elongation was nearly $14\frac{1}{2}$°, the phase $\frac{3}{100}$ and the brilliancy 23. Every evening after that until conjunction was cloudy or foggy; indeed, that evening was cloudy too, and it was only through a break in the clouds that she managed to let herself be seen for a minute or

two about a quarter of an hour before sunset,—*before* sunset not after. She looked bright enough to be good for three or four evenings yet, if the clouds or fog would only let her through.

At Marseilles the skies were clearer then, and M. Bruguiere got his last glimpse of her on the 27th, five days later than mine. At what time of the day I don't know, but as he counts it four days (instead of three) before conjunction, I think it must have been early in the day and probably about noon. In his longitude the time of conjunction was 2 a. m on May 1, so his observation could not very well be more than $3\frac{1}{2}$ days before. That is the closest in point of time that I know of. The elongation for Greenwich noon on the 27th was $7\frac{3}{4}°$, the phase less than $\frac{1}{100}$, and the brilliancy only 6.9. He succeeded in holding her again until about $4\frac{1}{2}$ days before the last inferior conjunction in December 1890, and though the elongation was then nearly 9°, the phase was a little less than before,—$\frac{2}{3}$ of $\frac{1}{100}$ only,—and the brilliancy was only 6.5. In smallness of phase and lowness of brilliancy this is the very best of all the observations that I have a record of, and it is probably as good as can be done. If any one cares to try to equal or better it, the first week in July will afford an opportunity to do so if the weather permits.

Perhaps it may be as well to collect into a couple of sentences the three or four chief facts mentioned above.

Venus's last complete season as evening-star began with the superior conjunction of February 18, 1890, and ended with the inferior conjunction of December 4, in the same year, lasting for a period of 290 days. I saw her with my naked eye as early as March 16, $26\frac{1}{2}$ days after superior conjunction, and M. Bruguiere saw her (in the same latitude) with his naked eye as late as November 29, $4\frac{1}{2}$ days before inferior conjunction; so she was visible to the naked eye during that season on 259 days, that is, on 89 days out of 100. When I saw her first in March she was only $6\frac{1}{2}°$ distant from the sun's centre, when M. Bruguiere saw her last in November the brilliancy was only $6\frac{1}{2}$ per cent. of her mean greatest brilliancy.

There is no reason why as good, if not a better, showing could

not be made for one of her morning-star seasons if some one would only take the trouble to turn out in the mornings and make the necessary observations at the beginning and end of the season.

So far, I have dealt with only one of the two questions that I proposed to treat when beginning to write, but the paper is already longer for the one subject than I hoped to make it for both. The second—as to the visibility of Venus to the naked eye in daylight—is the more interesting of the two, but it must stand over for the present. I may just say, however, that I have learned from Venus herself that it is not at all a rare or extraordinary thing to see her with the eye in broad daylight, and that no keen powers of vision are needed to see her so. On every clear day this year so far she could have been seen even at noon by any eye of average quality that knew where to look for her; and the same sight may be had by the same kind of eye on every clear day from now till the end of the year, excepting only a fortnight or so in July.

IV.—List of Localities for Trap Minerals in Nova Scotia.* By the late Rev. Thomas McCulloch, D. D., *President, and Professor of Moral Philosophy, Logic and Rhetoric, in Dalhousie University.*

(Read 14th December, 1891.)

TRAP DISTRICT.

LOCALITIES FOR MINERALS.

St. Mary's Bay.

Little River, Mink Cove.

Jasper in varieties.
Lamellar quartz, with calcareous spar.
White diabasie in geodes of quartz.
Magnetic iron ore.

Onward to Sandy Cove.

Geodes of quartz in jasper, transparent.
Geodes with amethyst, various shades.
Geodes with quartz, amethyst, and chabasie.
Lamellar quartz with calcareous spar in cavities.
Red, yellow and striped jasper in fissures.

Sandy Cove.

Stilbite in geodes of chalcedony.
Quartz crystals, fine.
Specular iron ore, brilliant,
Ditto, embedded in limpid chalcedony.
Ditto, in transparent chabasie.
Ditto, with quartz and calcareous spar.

* This is a very old list, and was found recently among the Museum specimens of the McCulloch Collection, presented to Dalhousie College by the Rev. William McCulloch, D. D., of Truro. The original manuscript bears neither date nor author's name, but, on its being forwarded to Rev. Dr. W. McCulloch, to ascertain if it was in his father's hand-writing, he replied : "You are right about the document enclosed. I had given it up as lost. It is in my father's hand, though the work was the joint labour of my father and brother Thomas, running over years."—George Lawson.

Calc spar.
Laumonite, beautiful crystals.
  Ditto, with calcareous spar in fissures.
  Ditto, with fine specular iron ore.
Agates.
Chalcedony.
Needlestone.
Quartz in veins—also disengaged.

Eastward a mile.

Specular iron ore, in rhombic crystals, plates and scales, best in disintegrated amygdaloid or friable black wad.
Magnetic iron ore.

Outer Sandy Cove, Bay of Fundy.

Jasper, red.
  Ditto, fine red and yellow cemented by quartz and amethyst.
Geodes of quartz and amethyst.
  Ditto, amethyst.
Agates, fine, in nodules and large tables, on the shore.
Agates, brecciated.
Hornstone.
Chalcedony.

St. Mary's Bay, eastward

Agates, fine varieties.
Jasper.
Chalcedony.
Amethyst.
Quartz.
Hornstone.
Calcareous spar.
Jasper, amethyst and chalcedony united.
Geodes of amethyst.
Cat's eye chalcedony.
Specular iron ore.

Titus Hill, St. M. Bay.

Striped jasper.
Jasper, cemented by chalcedony.
Ditto, hollow, with stalactites of quartz and jasper.
Calcareous spar.
Chabasie, dirty, crystals large.

Eastward.

Chalcedony in pebbles, cemented by siliceous ——.
Quartz crystals in cavities of jasper.
Amethystine quartz in delicate prisms.

Trout Cove, Bay of Fundy.

Agate, varieties, not found elsewhere on Digby Neck.
Chalcedony, fine.
Chalcedony, milk white, in veins.
Jasper, with zig-zag lines of carnelian, in trap.

Gulliver's Hole, Bay of Fundy.

Jasper, Chalcedony, Other minerals, } all in the debris.

Nichol's Mountain.

Amethyst in chalcedony.
Amethyst quartz and chalcedony united.
Magnetic ore in transparent chalcedony.

William's Brook, St. Mary's Bay, in the banks near the source of the brook.

Quartz, milky, radiated in amygdaloid.
Geodes of heulandite, fine, white, foliated, with radiated stilbite.
Geodes of heulandite, with green crystals supposed to be chabasie.
Cachalong, botryoidal, in quartz veins.

East of the Gut, six miles and onward.

Agates composed of lines of chalcedony, carnelian and cachalong.

Chute's Cove, both east and west.

Heliotrope, in stones, also dropped out.
Jasper and quartz in veins.
Chalcedony, white, in veins.
Carnelian, in plates.

St. Croix Cove.

Zeolites, fascicular, in cavities.
Ditto, four-sided prisms.
Heulandite, beautiful.
Ditto, foliated, in veins.
Mesotype, abundant in disintegrated soil.

Martial's Cove.

Zeolites, different species.
Heulandite, in veins, six inches wide.
Analceme, with globules of copper, green and transparent.
Copper.

Hadley's and Gates' Mountains.

Chlorophæite.
Thomsonite, in the fields, everywhere.
Mesotype, white, silky.

Peter's Point.

Laumonite, beautiful, in fissures.
Ditto, imbedded in rhombic calcareous crystals.
Apophyllite, fine.
Hornstone.
Jasper.
Laumonite, in fissures; also embedded in calcareous rhombic crystals.
Ditto, near the point under an arch of columnar trap, in a cave, well preserved, removable by hand.
Apophyllite, fine.

Honstone.
Jasper.

Toward French Cross and there.

Mesotype, fibrous, in amygdaloid.
Calcareous spar, in grottos, beautiful.
Heulandite, easily removed.
Zeolites, spheroidal, in amygdaloid, abundant.
Laumonite.
Mesotype, fine.
Jasper, Quartz, Chalcedony, } in veins.
Heulandite, unrivalled.
Chalcedony, botryoidal.
Quartz, geodiferous.
Stilbite.
Analceme, red.
Other minerals in the vicinity.

Toward Black Rock.

Mesotype and chlorite in amygdaloid.
Heulandite, red, with analceme.
Laumonite, beautiful, projecting out.

East of Black Rock, a few miles.

Calcareous spar, large veins, rich straw yellow.
Stilbite, in the *debris*, in masses, fasciculi, and in bundles of threads.
Jasper.
Chalcedony, milky.
Agates.
Prehnite.
Many other minerals.

Hall's Harbour.—No notices.

Onward on the road to Cornwallis.

Stilbite, in the fields.
Quartz, agate, jasper and chalcedony, at several places.

Cap d'Or.

West Side.

Copper in seams, best found at half tide.
Calcareous spar.
Analceme, tinged green, copper filaments enclosed.

East Side Horse Shoe Cove.

Copper in jasper,—ditto sulphate,—green carbonate.
Analceme, transparent.
Calcareous spar.
Ditto, incrusted with stilbite, like sugar.
Stilbite, radiated, in calcareons spar.
Many other minerals.

Spencer's Island.

Siliceous Sinter.
Jasper.
Quartz crystals.
Amethysts in geodes.
Agates.
Calcareous spar.
Stilbite.
Amethyst, splendent.

Partridge Island.

Calcareous spar, large crystals.
Stilbite.
Ditto, with calcareous spar, fasciculated, flesh red, and colourless.
Arragonite, transparent.
Yellow stilbite and calcareous spar, by breaking masses on the shore.
Chabasie in amygdaloid, transparent, orange, large and brilliant.
Agate.
Jasper.
Chalcedony.

Cachalong, botryoidal, in inaccessible trap, to be picked from debris.

Amethyst in geodes.

Hornstone, on the shore.

Opal and semi-opal.

Swan Creek.

Analceme, large plates.

Ditto, covered with needlestone.

Heulandite, pearly.

Ditto, in brown plates

Siliceous Sinter, with stilbite and heulandite

Chabasie, also, with the preceding; abundant minerals, eastward ½ mile.

McKay's Head.

Siliceous sinter in veins.

Ditto, in geodes, beautifully crystallized and in many forms.

Hogtooth spar.

Amethystine sinter in geodes.

Two Islands.

Chabasie,
Analceme,
Heulandite,
Calcareous spar,
Siliceous sinter, } abundant,—often in the same specimen.

Ditto, in cavities of amygdaloid, white, grey and amethystine.

Siliceous sinter in geodes, beautiful.

Moss agate, largest Island, east side, near a vein of ferruginous oxide at a mass of debris.

Jasper, beautiful, on the south side, in the outer Island.

Stilbite, rich.

Heulandite,
Analceme, } beautiful.

Five Islands.

Few minerals, inferior.

ART. V.—THE GEOLOGY OF CAPE BRETON—THE LOWER SILURIAN.— BY EDWIN GILPIN, JR., LL. D., F. R. S. C., ETC., *Inspector of Mines.*

(Read 9th May, 1892.)

IN my last paper I gave a brief sketch of the Devonian Measures of Cape Breton and now come to the Lower Silurian rocks. I have already drawn attention to the remarkably limited developments of geological horizons in this island. Between the basal conglomerate of the Carboniferous and the Pre-Cambrian there intervene only a few limited areas referred to the Devonian and the Lower Silurian. The Laurentian hills of the island may have borne on their crests much fuller representations of the geological sequence than are now presented, but evidence is not wanting to show that for long periods they must have stood as now, bare and patriarchal.

The Lower Silurian of Cape Breton rests frequently upon the Laurentian, and its conglomerates include pebbles of its felsites, gneisses, etc. It is in turn overlaid at many points by Lower Carboniferous strata, and has yielded its fragments to form the basal conglomerates of the latter formation. The fact that hitherto the Lower Carboniferous conglomerates have failed to yield pebbles differing from the Lower Silurian and Laurentian rocks, forms an argument in favor of the view that the Lower Silurian and Devonian alone in Cape Breton mark the gap already alluded to. This argument is the stronger because the Carboniferous conglomerates are composed of material derived from strata close to the point of formation. They do not, as in several cases in Nova Scotia, contain boulders and pebbles that have been carried many miles.

The extent of these Silurian strata is observed at many points by the overlying Carboniferous conglomerates, and at other localities they appear to have been preserved by the protection against denudation afforded by the Laurentian ridges. These strata are not found in the counties of Richmond or Inverness,

and are represented in Victoria County only by a small outcrop near Cape Dauphin, referred with doubt, in the absence of fossil evidence, to this age.

A long narrow band runs from Moore's Brook, in St. Andrew's Channel (Little Bras d'Or) along the shore to the mouth of McLeod's Brook, which it ascends to its source, and then follows Indian Brook down until within a mile of its mouth, at the Chapel on the Escasonic Indian Reserve on East Bay. Except at Owl's Brook, this band is no where over a mile in width. Long Island is entirely composed of the slates and limestones of this group. At the Long Island, Barasois and McSween's Brook there is an unconformable capping of conglomerate. At Dugald's Point the conglomerate completely obscures it, and rests upon the Boisdale felsites. No exposure of the Silurian strata is visible for several miles, until Maclean's Beach is reached, where it reappears as a narrow strip between the Laurentian and Conglomerate. This outcrop terminates at Shenacadie, but a small outlier is visible about a mile to the westward. Similar outliers occur on East Bay, near the mouths of Mackintosh and Bown's Brooks.

At the head of East Bay, these strata outcrop again resting on the syenitic masses of the Coxheath Hills, and are in turn obscured by the Carboniferous conglomerate. The northern edge of this exposure runs from the foot of Gillis Lake, and passes a little South of McAdams Lake and continues to a point on the East Bay road about one mile west of the bridge over Spruce Brook. This strip is about a mile wide in the centre and gradually narrows at each end.

The greatest development of this horizon, however, is met in the Mira River district, and here it has been carefully traced and minutely described by Mr. Fletcher of the Canadian Geological Survey.

The Mira River forms its northern boundary until a point on the northern bank is reached, about two miles east of Marion Bridge, where the formation is met on the north side of the river, covering a tract of land nearly square and about three miles broad. The next exposure on the north side of the river is met

at the mouth of Salmon River, where these measures are interposed between Lower Carboniferous limestone and Laurentian felsites. The felsite rocks cut out this patch and almost completely surround it. Still passing toward the head of the lake, after an interval of about a mile, the Silurian strata are met again, and occupy the shore of the lake to its head, and the banks of the Giant Lake River to the foot of Giant Lake. This exposure, about seven miles long and four wide, projects into the felsites of the Mira Hills, and is in several places pierced by masses of felsite.

The shore of the lower half of Giant Lake is occupied by syenites and felsites, succeeded in the upper half by the Silurian strata, which form a band about seven miles long and three wide terminating on the northern shore of the Upper Marie Joseph Lake. There are several small outliers in this district, at Five Islands Lake, and on the shores of Framboise Cove ponds.

A line drawn from the head of Mira River to the shore at the northern side of Catalogne Lake forms the extreme southern boundary of these measures. This line passes within about a mile and a half of the head of Gabarus Bay. While the Silurian measures are unbroken in the northern part of this district along the shore of the Mira River, they are broken into by isolated ridges and projections of the Laurentian felsites, etc., of the Gabarus district. Thus we find within and to the north of the line running from the head of Mira to Catalogne, the felsites, etc., of the White Granite Hills, the String Lakes, Blue Mountains, Bengal Lakes, and Catalogne Road.

The stratigraphical arrangement of these measures cannot now be made out with any degree of certainty. The plications imposed on the strata during succeeding ages, and the severe denudation which has ploughed the island so deeply, have left the sections imperfect. Generally speaking these measures are now presented as imperfect folds, having a general north-east and south-west course with cross foldings, having their origin in local irregularities of the surface of the Laurentian rocks, upon which they were deposited. It may also be inferred from the volume of conglomerates, grits and coarse sandstones presented at several

points in the districts under consideration, that the original thickness varied with the conditions of deposition, which would be paralleled by the facts observable among the overlying Basal Carboniferous rocks.

The exact position of these measures in the Geological Scale is not yet determinable with absolute certainty. When comparisons are made between geological horizons in Nova Scotia and those further west, or on the western side of the Continent of Europe, it is found that the general conditions characterizing such horizons on one side or the other do not necessarily prevail in Nova Scotia. Local peculiarities of surrounding land, and duration and conditions of deposition, have produced such changes that the geologist can but say, so far as can be judged, such and such a series corresponds best with such and such a group.

Dana, in his Geology, gives an excellent account of the Potsdam period, then regarded as the base of the Lower Silurian, and the geological sequent to the Azoic period, the period preceding the appearance of animal life. Since then there has been introduced horizon after horizon, until, between the base of his Lower Silurian and the true Azoic, there stretches now a long list of measures. Thus Sir J. William Dawson, writing about a year ago, places in descending order, below the Silurian, the Ordovician, embracing the Cobequid Series, &c., and the Caradoc and Bala felsites, Llandeilo and Arenig Series, &c; then the Cambrian, embracing the Mira and St. Andrews' Channel series, under consideration at present, and considered by Dr. Dawson as representing the Lingula flags of England. Then the Acadian series of St. John and the Atlantic gold-bearing rocks of Nova Scotia, followed by Basal Cambrian rocks observed in New Brunswick, but not yet recognized in Nova Scotia.

Then come the Huronian, considered as represented in Nova Scotia by certain rocks in Yarmouth County, and parts of the districts in Cape Breton mapped by the officers of the Geological Survey as Pre-Cambrian and Laurentian.

Fossils occur at numerous localities in these measures, and no doubt as they are more fully examined a very complete and characteristic horizon will be extablished.

At Young's Brook, in St. Andrew's Channel, are found in thin greenish and bluish slates impressions of an Obolella, and parts of a trilobite, considered by Mr. Billings of Quebec group age. Above McCormack's Road, in McLeod's Brook, are beds of comparatively unaltered slates, resembling Carboniferous grey and bluish shales. These beds have yielded many specimens of Dictyonema, Obolella, and an obscure Orthisina. Near Marion Bridge, on the Mira River, light colored and gray and reddish sandstones yield Obolella but of species differing from those met on St. Andrew's Channel. Mr. Fletcher writes:—Considered in regard to the occurrence of animal life the contorted felspathic shale, sandstone and limestones found at the mouth of Mackintosh Brook, and on the shore below Allan and Donald McAdam's, are of the highest interest. Many of the shales are blackened with the impressions of brachiopod shells, while some of the limestone is largely composed of them. Among the shells there are numerous phosphatic nodules, up to three-eighths of an inch in length. On examination they are found to consist of a fine bituminous paste, with minute irregular grains of silicious matter aud fragments of lingula, which is supposed to have formed the food of the animals which produced the coprolities, and which, it has been suggested, may have been some of the larger Trilobites.—These coprolites are not uncommon in rocks of various ages. It is supposed that the apatite deposits of Laurentian age, now worked to some extent for the manufacture of fertilizers, were aggregated and crystallised from wide spread phosphatic nodules similar to these but of much earlier date. Similar coprolites have been observed at Arisaig in rocks of Upper Silurian age, and I have seen them near Sutherland's River, in Pictou County, in strata probably the continuation of the Arisaig rocks. They are not, so far as yet observed, of economic value in Nova Scotia.

McNeil's Brook, south side of Mira, is a good hunting ground for fossils. Characterizing this horizon, Mr. Fletcher says: "Above McNeil's Mill the Brook exposes argillite and fine sandstone, including a bed of nodular bluish gray and black, bituminous, often granular, limestone, full of fossils, among which were recognised Orthis, Obolella and the head of a trilobite. Above

the bridge on Trout Brook Road gray, black and bluish argillites form cliffs abounding in impressions of trilobites, including Agnostus and an Olenus (or Sphœrophthalmus) allied to O. Alatus of Boeck." The amateur who is willing to work up this district will probably figure as the discoverer of many new and important varieties of the life characterizing this interesting series of strata.

On the shore at Long Island there is a good section of these measures exposed, but the beds are so disturbed by folding, faults, &c., that no estimate of thickness can be given. The following from Mr. Fletcher's measurements at this point will serve to show the general character of the rocks met here.

Sea green, and blue purple, whitish and gray, laminated, calcareous, hematitic felsites, micaceous slates and argillites, one color passing into another, with thin beds of compact felsite and quartzite. Red, coarse, calcareous sandstone, alternating with greenish, laminated, micaceous, pitted marl, in contorted rolls, from which the layers may be removed like the coats of an onion. Greenish and blue papery slates, often contorted. White waving, close grained quartzite and quartzose sandstone, sometimes felspathic. Mottled fine grained, ferruginous sandstone, arenaceous shale, and argillite, intersected by quartz and calcspar veins. A very common rock is a compact and slatey grey or bluish grey felsite, sometimes calcareous. In places the Pre-Cambrian Syenite has lying directly on it a fine grained felsite greenish, with glittering specks, and films of hematite. Many of the argillites of this district are comparatively unaltered, and are frequently mistaken for Carboniferous shales, so that explorations have been carried on in them in the expectation of striking coal. Limestone is not abundant, but the beds are at many points decidedly calcareous. At McLean's Point there are many reticulating veins of calc spar in the rocks, which sometimes form compact beds of limestone, having in places a cone in cone structure.

At many points there are conglomerates frequently resting on the Laurentian rocks. They are of various degrees of coarseness, and consist of felsites, syenites, porphyries, gneisses, etc..

from the rocks they rest on. It is possible that further investigations may result in the separation of the lower members of of this series into a sub-horizon. The present facies of the rocks of this formation and their fossils show their accumulation in comparatively shallow border waters, having a comparatively mild temperature. Presumably the outline of Cape Breton was then as now indicated most strikingly by the comparatively elevated lands of the precambrian, which, together with the older rocks of Newfoundland, protected the Gulf of St. Lawrence and gave sheltered waters for the accumulation of the Silurian slates and marls, some of which we now find comparatively unaffected by metamorphic action.

This set of rocks in Cape Breton has not yet been found to carry any important mineral deposits. Mr. Fletcher speaks of the abundant presence of iron oxide in the rocks between the Barasois and McSween's Brook on St. Andrew's Channel. In one or two places it impregnates the rocks so strongly as to form beds of iron ore which, however, on being traced, proved to become of inferior quality. At one place near McLean's point an opening has been made into a bed of red hematite of excellent quality, and a few tons extracted. Although irregular at the surface the bed appeared to become more defined in depth. On analysis it proved to contain—

Metallic iron, per cent.		62.50
Silica,	"	7.82
Phosphorus,	"	0.9
Sulphur,	"	trace.
Magnesia,	"	.88
Lime,	"	.67
Water,	"	1.10

I am not aware of any other deposits of iron ore in rocks of this age which promise to be of value. No mineral is more deceptive than iron ore. Its oxide spread in a thin film over boulders in a conglomerate and forming the cement of the mass has often led to the waste of large sums of money. A bed may be met giving the characteristic streak, color, &c., of an excellent

hematite, but a further examination shows that, perhaps, a few inches of the rock has been partially replaced by iron oxide, and that often yards away it has only enough iron in it to give a red color.

Traces of copper pyrites have been found at a few points in these rocks, but there does not seem to have been any igneous action paralleling that of the well-known copper fields of Lake Superior, and bringing up the metal from lower depths. It may, however, be found on further search that faults along lines of junction with the older rocks have permitted the accumulation of workable bodies of copper ore in these measures. Iron pyrites is not uncommon in layers of nodules, which at numerous places have made small beds of bog iron ore, a mineral not of much value until local furnaces are built. The soil overlying the Silurian strata is generally thin and cold, and in many places stony. Hitherto it has not attracted any appreciable amount of farming except at some points in the Mira River Valley, where presumably the present of limestone, &c., has given the soil some little superiority.

VI.—NOTES ON NOVA SCOTIAN ZOOLOGY, NO. 2.—BY HARRY PIERS.

(Read March 14th, 1892.)

In the following paper it is my desire to bring before the Institute of Science such notes of new, rare or otherwise interesting occurrences as have come to my knowledge or observation and been recorded in my note-book. The present contribution is the second of a series which, if acceptable, will be prepared as often as time and material warrant.* Had a periodical record of similar kind been previously published in our Transactions, I do not doubt it would have been of interest and service to such persons as myself who are occupied in studying the fauna of Nova Scotia. As it is, much valuable information has been lost through neglect to preserve it in such a way that it could be of future use in the formation of elaborate and more particular treatises. It is to remedy this that the present and previous collections of notes have been made. I wish to thank those who have always allowed me to inspect their collections, and who have ever been willing to stimulate me in my very pleasant duty of keeping Nature under police surveillance.

BIRDS.

KING EIDER *(Somateria spectabilis)*. Mr. T. J. Egan informs me that during the present spring (1892) he mounted three of these rare ducks. They were shot at Lawrencetown, Sambro and Musquodoboit.

CANADA GOOSE *(Branta canadensis)*. It was reported—whether correctly or not, I cannot say—that a flock of wild geese had been observed during its northern migration on February 23rd of this year (1892)†. The main body, however,

* The first number was published in the *Trans. N. S. Inst. of Nat. Sc.*, vol. vii, pp. 467-474.

† A letter in *Forest and Stream* said that a flock had been seen moving in Connecticut on February 10th, but that, no doubt, was merely a short local flight.

did not pass our locality until March 10th. During the afternoon of that day no less than ten very large flocks were seen within a short interval of time. Last year (1891) I noted the species on March 11th: in 1890, on March 17th; and in 1889, on March 8th. According to this, the average date of their first passage is about March 11th.

GREEN HERON *(Ardea virescens).* This is an uncommon species in our avifauna. Mr. W. A. Purcell, taxidermist of Halifax, obtained a specimen from Lawrencetown about April 20th, 1890, and shortly before the 15th of November, 1891, Mr. Arthur P. Silver was equally fortunate.

BLACK-CROWNED NIGHT HERON *(Nycticorax nycticorax nævius).* Only July 4th, 1889, Mr. Harry E. Austen, of Dartmouth, obtained a specimen of this rare wader, in full breeding plumage, at Cole Harbour, Halifax County.

VIRGINIA RAIL *(Rallus virginianus).* Rare in Nova Scotia. Mr. Purcell "set up" one which had been shot in the Province in November, 1890.

RED PHALAROPE *(Crymophilus julicarius).* On June 10th, 1891, Mr. H. E. Austen obtained one of these uncommon summer visitors from a couple of fishermen who, early in the morning of that day, had rowed up to the bird and captured it with their hands.* As it was alive, Mr. Austen took it home and kept it about a week. An account of the capture appeared in the *Ornithologist and Oologist*, Boston (vol, xvi, p. 111.), a periodical which frequently contains notes relating to our birds. While uncommon in this vicinity, I understand it is more abundant in the Bay of Fundy and at Cape Sable.

KILLDEER *(Ægialiteis vocifera).* This plover is usually very rare in Nova Scotia, but in the fall of 1888 a flight of large size was driven northward by a severe storm and for a while the birds were numerous along our shore. Dr. Arthur P. Chadbourne, who made a special study of the movements of this flock, and contributed his views to *The Auk* for July, 1889, con-

* According to Mr. Austen, the fishermen called it a "Gale Bird;" but as in Chamberlain's recent revision of Nuttall's Ornithology I find "Whale Bird" given as one of the vernaculars of this species, I am led to think that the similarity of sounds may have caused Mr. Austen to mistake the name by which his informers knew it.

siders that the birds while moving along the coast of Carolina had been blown to sea by a heavy gale and from thence driven in our direction. For several days after this occurrence, the birds were abundant from this Province to Rhode Island. In November, 1890, Mr. Purcell obtained a single specimen.

AMERICAN ROUGH-LEGGED HAWK *(Archibuteo lagopus sancti-johannis).* This bird has been becoming more rare than formerly, but during the past season several were taken. Two (a male and a female) were brought to Mr. Purcell, at different times, by "Josh" Umlah, who lives about seven miles from the city. I saw them both "in the flesh." The male was taken in a trap or snare about December 10th or 11th, 1891, and the female was shot on New Year's Day, 1892. Umlah said there was also a black-coloured hawk about his place: this was evidently one of the same species, but of the melanistic phase of plumage. About the middle of January, 1892, George Umlah of Harrietsfield shot a very dark-coloured hawk, but failed to bring it out of the woods, excusing himself on the ground that, as it was almost crow-black, he thought it would be of no interest. This was doubtless another of the very rare, dark individuals, a variety which is known by the name of "Black Hawk." Mr. T. J. Egan tells me that he had four of the birds in immature plumage, and one of the adult cr melanistic colour. They were all taken in the early part of 1892.

SAW-WHET OWL *(Nyctala acadica).* This pretty little owl which is becoming a rarity in Nova Scotia, was very frequently observed during February, 1892.* I do not attribute this to an increase in number, but rather to the fact that, owing to a great scarcity of their usual food, the birds were forced to leave the woods and come to the vicinity of dwellings. Just previous to February 18th, I recorded six which were observed by various people about my own home. Of this number two or three were picked up dead—evidently starved to death. In a single week preceding February 19th, Mr. Purcell received three specimens, one of which was found dead beneath a quantity of lumber on one of the city wharves. Mr. Downs informs me that several

*The ground was then covered with snow.

were brought to him, and Mr. Egan also mounted a number. The birds were extremely thin. To exemplify the courage of this little owl when oppressed by hunger, I may relate the following incident My father, when a boy, possessed a rat which he had trained and taught to draw a small cart. One day he and Mr. George Piers discovered a Saw-whet which they captured and placed in the room with the rat, and waited to see the result. Immediately the owl pounced upon the latter and fastened its claws in the animal's back. The rat feeling the bird upon him, ran a few times around a table, and then *both* fell over, dead. The Saw-whet, evidently in a starved condition, had spent all its energy in killing the rat, so that when the latter succumbed, the former also died from extreme exhaustion. Both owl and rat were given to Mr. Andrew Downs, who stuffed the two, and afterwards sent them to the first great exhibition held in London, 1862

SNOWY OWL *(Nyctea nyctea)* Usually the Snowy Owl is an uncommon visitor, but during occasional seasons they have been rather plentiful. The latter was the case during the winter of 1890–91, and a fair number were shot throughout the province. They were also reported more numerous than usual in other localities. During the same winter, the Snowflake *(P. nivalis)*, another northern bird, visited us in far greater numbers than has been its wont for many years. I noted many flocks of large size.

AMERICAN HAWK OWL *(Surnia ulula caparock)*. This owl has now become very rare. Mr. Andrew Downs was fortunate in securing one early in 1889, and I understand Mr. Austen has two in his collection.

YELLOW-BILLED FLYCATCHER *(Empidonax flavinentris)*. On June 29th, 1891, Mr. Austen collected two nests of this species at Dartmouth. They were each about three feet from the ground, the one in the fork of an alder and the other attached by its rim to a spruce-branch. The outside was formed of coarse grass while the lining was of the same material but of a finer kind. Measurements: circumference of top, outside, 10 inches; diameter and depth of cavity, 2½ inches. Each nest contained three eggs whose colour Mr. Austen describes as cream-white

with considerable variations in the markings. Some have a ring of red or reddish-brown blotches near the larger end, between which are minute red dots. Others have one or two reddish blotches on one side only, near the larger end, and some dots around the egg. In others, again, there is only a ring of little red spots.

CANADA JAY *(Perisoreus canadensis).* On May 3rd, 1889, Mr. Austen found a nest of this species, containing three eggs. It was built in a grove of spruces, and was six feet from the ground. On April 22nd of the present year (1892), he obtained another nest in the vicinity of Porter's Lake, near Dartmouth. It was a large structure, placed on one of the limbs of a low spruce tree. Outside, it was composed of twigs of the Balsam Fir, (*A. balsamea*); within this, was a thickness of fine grass, moss, and small twigs; and inside of all, the bird had arranged a complete lining of feathers of the Ruffed Grouse (*B. umbellus togata*). There were two eggs, which Mr. Austen tells me were coloured yellowish gray and rather light green, dotted *very* finely with brown and slate. The eggs of this Jay are very rare, and the price of a single specimen is as high as a dollar and a quarter.

AMERICAN CROW (*Corvus americanus*). A curious freak of nature was shot at McNab's Island, near Halifax, in the early part of October, 1891. This rarity was a Crow, one of whose tail feathers was altogether *pure white*, while the remaining ones were of the normal colour. The rest of the plumage was as usual black, and the eyes were likewise of the ordinary colour. It is in Mr. Purcell's collection.

BAY-BREASTED WARBLER *(Dendroica castanea).* On June 20th, 1891, Mr. Austen observed this uncommon species at Dartmouth, and thinking it probable that a nest was in the neighbourhood, he proceeded to make a thorough search. Nearly three hours had elapsed before the structure was discovered. It was placed on a hemlock bough, about seven feet from the trunk, and some twenty feet from the ground, while above was another branch covering and concealing it. At that time the birds had not completed its construction. On June 24th it contained one egg, and on the 29th, two. Thus it remained until

July 3rd, when, still holding only the pair of eggs, Mr. Austen took both them and the nest. The outside of the latter was formed of grass with pine-needles and pieces of twigs. Without, the diameter was 4 inches, and depth, 2. Breadth of cavity, 2¼ inches; depth, 1 inch. Mr. Austen describes the eggs as being of a "bluish green tinge, speckled with reddish brown, and with a complete ring of dark-red blotches around the larger end." The identification was complete. Eggs of this species have been priced at a dollar and seventy-five cents each, which shows that their rarity is such that any description of them will be of interest.

YELLOW PALM WARBLER *(Dendroica palmarum hypochrysea)*. In 1863, Mr. William Winton sent to Professor Baird, of the Smithsonian Institution, the eggs of this species which he had collected at Stewiacke, N. S. This was the first time Baird had ever seen them. On May 26th, 1891, Mr. Austen found a nest containing four eggs at Dartmouth. It was in a wet piece of ground, sunk a little below the level of the soil, and partially concealed by a dead branch. The structure was formed, outside, of grasses, bits of moss, and fine roots, while the inside was lined with very fine grass, then a few black horse-hairs, and within all a lining of feathers. Its depth outside was 2½ inches; depth inside, 1¾ inches; breadth inside, 2 inches; circumference outside, at top, 11½ inches; circumference outside, at bottom, 9¾ inches. Mr. Austen describes the eggs as white, with a faint reddish tinge, dotted indistinctly with red, and one or two scattered blotches; larger end marked with a ring of reddish and brown blotches of various sizes. The set is now in the collection of Mr. J. Parker Norris, of Philadelphia.

WINTER WREN *(Troglodytes hiemalis)*. On June 5th, 1891, I obtained the nest and eggs of this species at Kidston's Lake, near the "Rocking-stone," (Spryfield, Halifax County.) As its breeding habits are very little known to naturalists, I intend to devote some space to a detailed description of this rare nest and eggs, in a paper which I hope shortly to read before the Institute. The rarity of the Winter Wren's eggs will be evident when I

note that a New York oologist quotes them in one of his price-lists at a dollar apiece.

RUBY-CROWNED KINGLET (*Regulus calendula*). In 1891 Mr. Austen found two more nests of this Kinglet. The first was taken on June 12th, and contained six eggs. The second one, full of young, was discovered two days later at the very top (about forty feet from ground) of a black spruce, and placed under the sustaining branch, to which it was hanging by little twigs. Neither nest could be seen from the ground.

REPTILES.

RING SNAKE (*Diadophis punctatus*). On May 15th, 1891, Mr. M. Y. Gray gave me a small living snake which he had captured on the 10th of that month, in a sandy place close to the Prince's Lodge, Bedford Basin. When found, it was lying motionless, coiled like the figure 8. I easily identified it by the yellowish occipital ring, as belonging to the species *Diadophis punctatus*, a very rare snake in this province, and which Mr. John T. Mellish* does not think occurs at all in Prince Edward Island. My specimen is small—only 5¼ inches in length,—but very pretty. For some time I kept it alive, and it proved of much interest. The warmth of my skin was evidently pleasant to the reptile and it crawled over the hand and went around and between the fingers, occasionally thrusting out its tongue but never attempting to bite or make its escape. The following description may be of use in comparing this individual with others from distant localities:

Upper labials 8; 6th and 7th largest, 4th and 5th forming the lower part of the orbit. Lower labials 8; 5th the largest. *Colour* (before fading in alcohol): Above slightly lustrous, black (or nearly so) with steel-blue reflections. Head above, same colour but more lustrous. Body and tail beneath, reddish-orange, more red on posterior part. A series of black sub-triangular spots along the lateral margins of the scutellæ, and in contact with the dark colour of the flanks. No black

*Notes on the Serpents of Prince Edward Island. *Trans. N. S. Inst. Nat. Sc.*, vol. IV., pp. 163-167.

dots along middle region of abdomen. Tip of tail for about one-thirtieth of an inch, all black (this is hardly noticeable, except when examined closely). Occipital ring of the width of two scales, not interrupted, colour of anterior part of body beneath. Head beneath and upper labials, pale flesh-colour. Iris and pupil black.

Number of abdominal scutellæ from chin to anus, 155+1.

Number of pairs of subcaudal scutellæ, 56.

Number of dorsal rows of scales around the body (excluding the abdominal series), 15.

Total length (tip of snout to tip of tail), 5¼ inches.

Length of tail (anus to tip), 1·09 inches.

The late Mr J. M. Jones, in his paper entitled "Contributions to the Natural History of Nova Scotia: Reptilia,"* speaks of the Ring Snake as our rarest species, and Dr. J. Bernard Gilpin † likewise considered it very uncommon. The former gentleman records only two specimens—one taken at Annapolis by Dr. Gilpin, and the other captured in September, 1863, at Mr. Andrew Downs' place near Halifax. Dr. Gilpin has only recorded one, which he captured at Fairy Lake, September, 1870, and for which he sacrificed a small flask of whiskey in order to preserve the valuable specimen. Some twenty-five or thirty years ago, my father, Mr. Henry Piers, saw one of these snakes swimming with great ease across the water at "Stony Beach," about twelve miles from Halifax, on the road to Prospect. The animal was about a foot and a half long, and the yellowish occipital ring was conspicuous. In 1885 a popular English periodical contained a few notes on snakes in captivity, written at Halifax, in which the writer spoke of having a Ring Snake which had been captured near the city in the summer of 1885. It must of course be understood that this, coming from an unscientific source, cannot be vouched for. I may say that I have now been so fortunate as to have personally observed all the serpents known to occur in Nova Scotia, two of which are extremely rare.

* *Trans. N. S. Inst. Nat. Sc.*, Vol. I., pt. 3, pp. 114-128.

† "On the Serpents of Nova Scotia," *Trans. N. S. Inst. Nat. Sc.*, Vol. IV., pp. 80-88

VERMILLION-SPOTTED NEWT (*Diemyctylus viridescens*).* My brothers, Mr. Charlie and Sidney Piers, while fishing at Bayer's Lake near the St. Margaret's Bay Road, May 21st, 1891, netted one of these beautiful reptiles as it swam through the water. It was a viridescent adult. I placed the animal in water and observed its habits and movements, which interested me much. The following pigmental description, written while it was alive, should be of advantage, as specimens immersed in alcohol lose certain of their colours which are extracted or altered by the spirit:

Whole animal with exception of top and sides of head and portions of legs, spotted or punctured, in a greater or less degree, with black. Above, olive brown, slightly darker on back and head. Obscure superciliary line of a colour lighter than upper part of head. On each side of the vertebræ are three crimson spots encircled with black. They are not, however, regularly opposite each other. The anterior one on the left side is a little posterior to the fore-leg; the second one on the same side is ·17 of an inch behind the anterior one; and the third or posterior one is ·30 of an inch behind the second. On the right side the anterior spot is opposite the second spot on left side; the second is ·23 of an inch behind the first; and the posterior one is opposite the posterior one on the left side. Beneath, yellowish, lighter on under side of head. Lower half of tail not much lighter than upper half. Line of demarcation between the olive-brown of the upper part of animal and the yellowish colour of the lower portion, is fairly distinct; it proceeds from the snout along the sides of the head and body to the anus (which is a little posterior to the hind-legs.) Irides golden with black mark across.

Snout to fore-leg	·55	ins.
" hind-leg	1·40	"
" anterior crimson spot on left side...	·70	"

*This Newt was formerly a great puzzle to naturalists, and its red, yellow-red, viridescent, or intermediate phases of colouration, led to such being considered as distinct species. My specimen agrees with what was formerly known as the Crimson-spotted Triton (*Triton millepunctatus*), which is the viridescent or greenish state. Those who are interested in the life-history of this species and its regular change in colour as well as habitat, should consult S. H. Gage's paper entitled, "Life-History of the Vermillion-spotted Newt," in *The American Naturalist*, Vol. XXV, pp. 1084-1110 (Dec., 1891).

When laid on the carpet the reptile crawled very slowly and awkwardly, but it was perfectly at home when placed in a bottle of water. There it used its feet to assist the tail in propelling the body, and the tail when so employed, moved in a sinuous manner. Respiration in liquid occurred from two to three times a minute.

FISHES.

BAUMARIS SHARK (*Lamna cornubica*). On April 10th, 1891, a shark was found off Sambro by Captain John Brown of Herring Cove, pierced through the tail by a trawl-hook and unable to free itself. It was secured with much difficulty and brought to this city where I examined it and prepared detailed drawings. It proved to be the Porbeagle or Baumaris Shark, a species common to both sides of the Atlantic, and elsewhere. This is the first record I know of its capture in these waters, although of course it was to be expected. Mr. J. Matthew Jones does not include it in his excellent catalogue of our fishes, and neither does Knight nor Perley in those which they prepared. The present specimen weighed four hundred pounds, and its extreme length from tip of snout to tip of caudal, was seven feet three and a half inches. When dissected, it was found that the stomach contained a whole Cod (*G. morrhua*) weighing four or five pounds, together with the head of another Cod, and also a Hake (*P. tenuis*) of about the same size as the entire Cod. The liver was greenish-yellow.

VII.—Catalogue of Silurian Fossils from Arisaig, Nova Scotia. By Henry M. Ami, M.A., F.G.S.

(Read April 11th, 1892.)

Through the palæontological writings of Salter, Billings, Dawson, Honeyman, Hall and Jones—the fauna of the Silurian rocks of Arisaig have been made widely known and notable both on account of the abundance and variety of its forms, as well as on account of the remarkable continuity and unbroken sequence of the strata from which these organic remains have been obtained.

In the Quarterly Journal of the Geological Society of London, in the Canadian Naturalist, and Nova Scotian Institute of Natural Science Transactions, as well as in the Reports of the Geological Survey of Canada, the above-mentioned authors have described and recorded numerous new, interesting and previously unknown forms.

During the season of 1886, Mr. T. C. Weston, accompanied by Mr. J. A. Robert, made important collections of fossils in the rocks constituting the stratigraphical series at Arisaig, along the coast, in connection with the geological work entrusted by Dr. Selwyn to Mr. Hugh Fletcher, and amongst them were several new and hitherto unrecorded forms, besides good examples of species which had been previously considered or doubtfully identified.

These collections, as well as others from Nova Scotia, having been placed in my hands for determination during the season of 1886-87, I have applied myself to identify the various forms present.

Amongst the Arisaig collections alone I have been able to recognise no less than 163 species, which are divisible into groups as follows:—

	No. of Species.
Plantæ	3
Rhabdophora	6
Polypi	3
Brachiopoda	44
Lamellibranchiata	59
Pteropoda	8
Gasteropoda	9
Cephalopoda	13
Vermes	4
Ostracoda	7
Trilobita	6
Merostomata	1
Total	163

The species included in the above enumeration are all Silurian (Upper Silurian), and represent horizons from the base of that epoch to its summit, which, according to the New York and Ontario system and equivalencies, would indicate from the *Medina* to the *Lower Helderberg*, both inclusive, and according to British nomenclature, include from the Llandovery to the upper members of the Ludlow.

It is but natural to point out here that, in examining the fauna of these Arisaig rocks, I have found a most intimate relation existing between it and the fauna of rocks assigned to a similar horizon in Europe along the Atlantic border.

In fact, the intimacy may be said to be much closer between the Arisaig fossils and those, for instance, of the Ludlow rocks of Kendal, in Westmoreland, England, than with either the Silurian rocks of Anticosti, of Ontario or of New York State.

The following is a classified list of the organic remains collected by Mr. T. C. Weston in 1886 in Divisions A, B, B′, C and D of the Arisaig Section, according to the late Rev. Dr. Honeyman and Mr. Hugh Fletcher, B. A.

It is hoped to supplement this catalogue shortly with full descriptions of the new forms herein mentioned, and notes on other interesting species, which are but little known or previously unrecorded

SILURIAN FOSSILS FROM ARISAIG, NOVA SCOTIA.

LIST OF SPECIES.

PLANTÆ.

1. Palæophycus sp.
2. Psilophyton (?) sp.
3. Obscure fucoidal remains, uncertain.

RHABDOPHORA.

4. Monograptus Clintonensis, Hall.
5. " Halli, Barrande.
6. " Riccartonensis, Lapworth
7. " Sandersoni (?) Lapworth.
8. " sp. indt.
9. " (?) sp. (?)

POLYPI.

10. Cladopora seriata, Hall.
11. Streptelasma patula, Rominger.
12. " sp. nov.

BRACHIOPODA.

13. Lingula spathata, Hall.
14. " rectilatera, Hall.
15. " lamellata? Hall.
16. " oblonga, Conrad.
17. " sp. indt.
18. Leptobolus sp.
19. Discina tenuilamellata, Hall.
20. " " v. subplana, Hall.
21. " Vanuxemi, Hall.
22. " sp.
23. Pholidops implicata, Sowerby.
24. Chonetes Nova-Scotica, Hall.
25. " tenuistriata, Hall.

26. Orthis elegantula, Dalman.
27. " hybrida ? Sowerby.
28. " subcarinata, Hall.
29. " n. sp.
30. " polygramma, Sowerby.
31. " rustica, Sowerby.
32. " sp. indt.
33. Platystrophia biforata, v. lynx, Eichwald.
34. Skenidium pyramidale, Hall.
35. Strophomena euglypha ? Sowerby.
36. " rhomboidalis, Wilckens.
37. " expansa, Sowerby.
38. " corrugata ? Conrad.
39. " subplana, Hall.
40. " varistriata, v. arata, Hall
41. Spirifer crispus ? Hisniger.
42. " rugæcostus, Hall.
43. " subsulcatus, Hall.
44. Atrypa reticularis, Linnæus.
45. " sp.
46. Rhynchonella æquiradiata, Hall.
47. " emacerata, Hall.
48. " formosa, Hall.
49. " neglecta, Hall.
50. " sinuata, Hall.
51. " Saffordi, Hall.
52. " sp. indt.
53. Pentamerus Knighti, Sowerby.
54. (?) sp.
55. Leptocœlia hemispherica, Sowerby.
56. " intermedia, Hall.

LAMELLIBRANCHIATA.

57. Orthonota curta, Hall.
58. " incerta, Billings.
59. " simulans ? Billings.
60. " n. sp.

61. Orthonota sp. indt.
62. ? Leptodomus truncatus, McCoy.
63. Sanguinolites anguliferus, McCoy.
64. " carinatus, McCoy (sp.).
65. Grammysia Acadica, Billings.
66. " cingulata, Hisinger.
67. " " var triangulata, Salter.
68. " remota, Billings.
69. Goniophora bellula, Billings.
70. " transiens, Billings.
71. " N. sp.
72. " sp. indt.
73. Cleidophorus erectus, Hall.
74. " concentricus, Hall.
75. " cuneatus, Hall.
76. " nuculiformis, Hall.
77. " semiradiatus, Hall.
78. " subovatus, Hall.
79. " sp. allied to C. subovatus, H.
80. Anodontopsis angustifrons, McCoy.
81. " ? N. sp.
82. Cucullella elongata, Hall, sp. (=Cleidophorus elongatus, H.)
83. Cucullella N. sp. No. 1.
84. " N. sp. No. 2.
85. Cytherodon ? placidus, Billings.
86. " socialis, Billings.
87. " N. sp.
88. Ctenodonta angusta, Hall sp.
89. " " n. var. or n. sp.
90. " attenuata, Hall sp.
91. " n. sp.
92. " equilatera, Hall sp.
93. " elliptica, Hall.
94. " sp. indt.
95. Megambonia cancellata, Hall.
96. " hians ? McCoy.

97. Megambonia striata, Hall.
98. Modiolopsis exilis, Billings.
99. " rhomboidea, Hall.
100. Ambonychia ? n. sp.
101. Posidonomya, sp. indt.
102. Posidonia alata, Hall.
103. Pterinotella curta, Billings.
104. " venusta, Hall.
105. " n. sp.
106. Pterinea emacerata, Conrad.
107. " Honeymani, Hall sp.
108. " limiformis, Hall.
109. " manticula, Hall.
110. " orbiculata, Hall.
111. " textilis, Hall.
112. " sp. nov.
113. " sp. nov. (?)
114. " sp. indt.
115. " asperula, McCoy.

PTERAPODA.

116. Conularia Niagarensis, Hall.
117. Tentaculites distans, Hall.
118. " elongatus, Hall.
119. " minutus, Hall.
120. " Niagarensis, Hall.
121. " n. sp.
122. " sp. indt
123. Theca n. sp.

GASTEROPODA.

124. Pleurotomaria Halei ? Hall.
125. " sp.
126. Murchisonia Arisaigensis, Hall.
127. " subulata, Conrad.
128. " cf. M. Conradi, Hall.

129. Cyclonema cancellatum, Hall.
130. " obsoletum ? Hall.
131. " n. sp., No. 1.
132. " n. sp., No. 2.

CEPHALOPODA.

133. ? Discosurus conoideus, Hall.
134. Cyrtoceras ? sp.
135. Orthoceras elegantulum, Dawson.
136. " longicameratum ? Hall.
137. " exornatum, Dawson.
138. " punctostriatum, Hall.
139. " virgatum ? Sowerby.
140. " rigidum ? Hall.
141. " sp. No. 1.
142. " sp. No. 2.
143. " sp. No. 3.
144. " sp. No. 4.
145. Oncoceras sp.

VERMES.

146. Conchicholites sp.
147. Cornulites flexuosus, Hall.
148. " " v. gracilis, Hall.
149. Serpulites dispar, Salter

OSTRACODA.

150. Primitia mundula, Jones.
151. " ovata ? Jones and Hall.
152. Beyrichia æquilatera, Hall.
153. " tuberculata, Klœden.
154. " " v. pustulosa, Hall.
155. " " v. strictispiralis, Jones.
156. " " v. Nœtlingi, Reuter.

TRILOBITA.

157. Calymene Blumenbachi, Brongniart.
158. Homalonotus sp.
159. " Dawsoni, Hall.
160. Phacops ? sp.
161. Dalmania Logani, Hall.
162. Acidaspis tuberculatus ? Conrad.

MEROSTOMATA.

163. Stylonurus ? sp. nov.

OTTAWA, March 7th, 1892.

VIII.—On the Graphical Treatment of the Inertia of the Connecting Rod—By Prof. J. G. MacGregor, D. Sc., Dalhousie College, Halifax, N. S.

(*Received June 15th, 1892*).

In slow-speed steam engines, no great error is introduced in calculating the effort of the connecting rod on the crank-pin, on the assumption that the connecting rod is without mass. In high-speed engines, however, a ccnsiderable error is thus introduced; and it is therefore desirable to have a method of determining the actual effort. In this paper a graphical method of making the determination is described.

The effort transmitted by the connecting rod is affected by the weight of the rod as well as by its inertia, and also by the friction of the surfaces in contact. The effect of the weight of the rod and of friction, however, may be found by well known methods. I shall therefore assume the rod to be weightless (though not massless), and the surfaces in contact to be smooth.

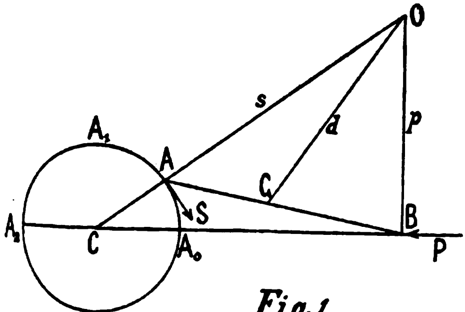


Fig. 1.

Let CA be the centre line of the crank of the ordinary steam engine, and AB that of the connecting rod, BC being thus the line of the piston's motion. The end B of AB therefore moves to and fro in the line BC, while the crank-pin A moves in the circle $A_0\ A_1\ A_2$. The motion of these points is regulated by the flywheel. If the engine have a flywheel of sufficiently great moment of inertia, A will move in its circle with practically uniform speed. If the moment of

inertia be not sufficiently great for this purpose, fluctuations of speed will occur, which, apart from the solution of the present problem, may be determined approximately. We may therefore regard the velocity of the crank-pin A as known for all positions of the crank.

The motion of the connecting rod is thus one of the data of the problem. As is well known, it may be regarded as rotating instantaneously about a fixed axis whose position is the intersection O, of the line CA produced, with a line through B perpendicular to BC. The distances of O from A and B for any position of the crank may be found by drawing to scale a diagram similar to Fig. 1 and measuring the lengths of the lines AO and BO. We shall use the symbols s and p to indicate these distances respectively.

The forces acting on the connecting rod are (its weight being neglected) the force exerted on the end B by the crosshead of the piston rod, and the resistance of the crank-pin acting on the end A, which is of course equal and opposite to the force exerted by the rod on the crank-pin. As we are neglecting friction, these forces may be considered as acting through the points B and A, the centres of the pins. They may be resolved into components in and perpendicular to the lines of motion of B and A respectively. Let P and S be the components in the lines of motion. The indicator diagram, the area of the piston, and the mass of the reciprocating parts, being given, P may readily be determined for all positions of the crank. S is the force which it is desired to determine.

The simplest relation between these forces and the kinetic changes which the connecting rod is given as undergoing, is that expressed in the equation of energy. Let dc be the length of arc described by the crank-pin A, during any small displacement of the rod. Then, as the rod is instantaneously rotating about O, $(p/s)dc$ will be the distance traversed in the same time by B. Hence the work done by the forces acting on the rod is

$$P(p/s)dc - Sdc\,;$$

for the component forces perpendicular to the lines of motion of A and B do no work. The work done must be equal to the in-

crement of the kinetic energy of the rod. As the rod is rotating about the point O, instantaneously fixed, its kinetic energy is $\frac{1}{2}\omega^2mk^2$, where ω is its angular velocity about O, m its mass, and k its radius of gyration about an axis through O perpendicular to the plane of motion. Hence the equation of energy is:

$$(P\frac{p}{s} - S)\,dc = d(\tfrac{1}{2}\,\omega^2mk^2),$$

or

$$P\frac{p}{s} - S = \frac{d}{dc}(\tfrac{1}{2}\,\omega^2mk^2).$$

In this equation P, p and s are known as pointed out above, for all crank positions, *i. e.*, for all values of c. The mass m is known. The angular velocity ω may easily be found; for it is equal to the linear velocity of the crank-pin divided by s, the distance of the pin from O; and the angular velocity of the crank being given, together with its length, the linear velocity of the crank-pin may be obtained at once. The radius of gyration, k, about O is equal to the square root of the sum of the squares of the radius of gyration, h, about a parallel axis through G, the centre of mass of the rod, which is constant and may be calculated, the form and dimensions of the rod being given, and of the distance, d, of G from O, which may be found for all crank positions by measuring the length of the line GO in diagrams similar to Fig. 1. All the variable quantities of the above equation except S may thus be expressed as functions of c. It is therefore sufficient for the determination of S.

Usually, however, the problem under consideration is presented in this way:—By what amount is the component, normal to the crank, of the effort on the crank-pin too great, when calculated on the assumption that the connecting rod has no inertia? Or in other words, what pull normal to the crank must the crank-pin exert on the rod, in order that the rod may move in the given way?

The equation of energy modified so as to be a direct answer to this question takes a somewhat simpler form. For if S' be the component normal to the crank of the effort on the crank-pin, calculated on the assumption referred to, we have, putting $m = o$,

$$P\,(p/s) - S' = o.$$

Hence the amount by which the required force is too great when calculated in this way, is given by the equation:

$$S' - S = \frac{d}{dc}(\tfrac{1}{2}\,\omega^2 mk^2).$$

This expression lends itself readily to graphical treatment. For this purpose we find ω for various crank positions, by drawing diagrams similar to Fig. 1 for as many positions of the crank as may be desired, measuring the lengths s in these positions and dividing the values of the velocity, V, of the pin for these positions by the corresponding values of s. We then plot a curve with distances traversed by the crank-pin from some initial position such as A_0, as abscissæ, and the corresponding values of ω as ordinates, thus obtaining a curve which gives us the values of ω for all crank positions. Then selecting points on this curve, whose ordinates have simple values, such as can be raised to the square "in the head," or by reference to a table of squares, we obtain a series of values of ω^2 for the selected crank positions; and a second curve giving the variation of ω^2 with the crank position may be plotted. Or as $\omega^2 = \omega\, V/s$, we may obtain the ω^2 curve from the ω curve by the construction by which we obtain the curve vv from the curve VV below, V and s taking the place of the k and s used in that construction.

A similar curve for k^2 must next be obtained. As $k^2 = h^2 + d^2$, its values for different positions of the crank may be obtained by finding the values of d from the diagrams similar to Fig. 1, already drawn, and adding their squares to the square of the constant h. For this purpose draw a right-angled triangle abc (a diagram is not necessary), whose sides ab and bc, containing the right angle, represent on any convenient scale the quantities h and d. Then the hypothenuse ac will represent to the same scale $\sqrt{h^2 + d^2}$ or k. From a point e in ac at a distance from a or c, say a, of one scale division, draw a line ef, in any direction, equal to ac; join af, and through c draw a line parallel to ef and meeting af produced in g. The line cg will represent $h^2 + d^2$ or k^2 to the same scale as ab and bc represent h and d.

The ω^2 curve and the k^2 curve must now be combined so as to

give an $\omega^2 k^2$ curve. This may readily be done, either by the ordinary process of graphical multiplication or by selecting points in either curve which have ordinates of simple value and multiplying by them the corresponding ordinates of the other. The corresponding ordinates of the $\omega^2 k^2$ curve are thus obtained, and the curve may then be plotted. The quantity $\frac{1}{2} m$ being a constant, this curve, read to the proper scale, will also be a curve giving the values of $\frac{1}{2}m\omega^2k^2$ for all crank positions; and the tangent of the inclination to the axis of crank positions, of the tangent to this curve at any point, is the value of $S' - S$ for the corresponding crank position.

This process, however, is laborious, and the above equation may be thrown into a form which gives a much simpler graphical treatment. For this purpose the two variable quantities, ω and k, are combined in one, the product, ωk, being obviously the velocity of any point rigidly connected with the rod and at a distance from O equal to k. If we call this velocity v we have

$$S' - S = \frac{d}{dc}\left(\tfrac{1}{2}mv^2\right),$$

$$= mv\frac{dv}{dc}.$$

In this expression there is but one quantity, v, varying with c. It leads, therefore, to a very simple graphical treatment.

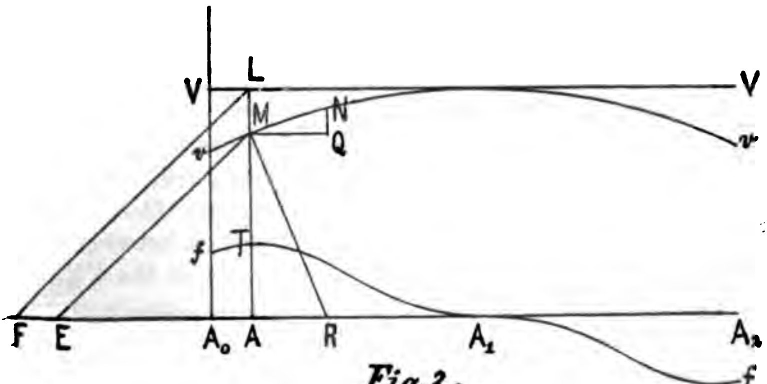


Fig. 2.

Let A_0A_2 (Fig. 2) be the straight line or axis on which distances (c) traversed by the crank-pin are represented, A_0A, for

example, representing, on some convenient scale of distances, the length of the arc A_0A in Fig. 1. Let the ordinate AL represent, on some convenient scale of velocities, the velocity of the crank-pin in the crank position represented by A (Figs. 1 and 2.) A smooth curve, VV, drawn through L and a sufficient number of points similarly determined, gives the velocity of the crank-pin in all crank positions. As seen above, if the moment of inertia of the fly-wheel be sufficiently great, it will be practically a straight line; if not, it will be a known curve.

The value of the velocity, V, of the crank-pin being known for all positions of the crank, the velocity, v, of the above formula, may be obtained at once; for, as the rod is instantaneously rotating about O, we have

$$v = \omega k = \frac{V}{s}k.$$

To find the value of v corresponding to the crank position A, cut off from AA_0 produced (Fig. 2), AE and AF representing on any scale k and s respectively (obtained as on p. 196 and from Fig. 1); join FL, and through E draw a line parallel to FL and intersecting AL in M. Then we have

$$AM = AL\frac{AE}{AF} = V\frac{k}{s}.$$

Hence AM represents v to the same scale as AL represents V; and M is therefore a point on the curve which gives the values of v for all crank positions. Other points may be similarly determined, and a smooth curve, $v\ v$, may then be drawn through them. Its form is roughly indicated in Fig. 2, which is not, however, drawn to scale. It will obviously touch the VV curve at the crank position A_1, (Figs 1 and 2), the rod in that position having a motion of translation only (O being at an infinite distance). In all other crank positions between A_0 and A_2 its ordinates will be less than the ordinates of the VV curve. Obviously the lines FL and EM need not be actually drawn in the above construction; it is sufficient to mark their end points.

From this curve we may find the values of vdv/dc for all crank positions. Thus for the position A:—Let N be a point on the curve $v\ v$, near M. From M and N draw MQ and NQ parallel to

the axes of crank positions and of velocities respectively. Then MQ and NQ are the values of dc and dv for a small displacement of the rod from the crank position A; and when the displacement is made indefinitely small, NQ/MQ becomes ultimately the dv/dc of the above formula, and MN becomes a straight line. From M draw MR a normal to the curve at M. Then, since MN, NQ and QM are perpendicular to MR, RA and AM respectively, the triangles MNQ and MRA are similar. Hence

$$AR = AM\frac{NQ}{MQ} = v\frac{dv}{dc}.$$

From AL cut off a part AT equal to AR. Then T is a point on a curve whose ordinates represent on some scale to be determined, the values of vdv/dc for all crank positions. Other points may be similarly determined, and a smooth curve drawn through them. Its form is roughly indicated in Fig. 2 by the curve ff. The dv and dc at the crank position A, being both increments, and vdv/dc being therefore positive, AT is drawn upwards. Between A_1 and A_2, dv is a decrement; vdv/dc is thus negative; and hence the ordinates of ff are there drawn downwards. Obviously the lines MQ and NQ do not require to be drawn in making the construction. They are introduced above for purposes of proof. Nor does MR require to be drawn. It is necessary only to mark its end point R. If the drawing be made on co-ordinate paper, the line MA will be a line on the paper.

The mass m being a constant, $S' - S$ is proportional to vdv/dc, and its values in different crank positions will therefore be represented by the same straight lines which represent the values of vdv/dc. Hence the curve ff gives not only the values of vdv/dc, but also, if read to the proper scale, the values of $S' - S$ for all crank positions. If this scale be determined therefore the problem is solved.

There are four steps in the above method of obtaining values of $S' - S$. First the curve VV is drawn from data of the problem. In order to draw it, scales of velocity and of distance or length must first be selected; which means that we must select convenient units of velocity and length for the purposes of our

geometrical constructions. Let us suppose we select 9 inches (equal to $\frac{3}{4}$ ft.) to be represented by one division of the distance scale, and 10 feet per second to be represented by one division of the velocity scale.

Secondly, the curve, *vv*, is obtained from the curve, *VV*; and as seen above the scales of the two curves are the same.

Thirdly, the curve, *ff*, is obtained from *vv* by applying a geometrical construction, which is the equivalent of the algebraic operation indicated by the expression vdv/dc. Hence the scale of the ordinates of the curve *ff* must be related to the velocity and distance scales in the same way as the unit of vdv/dc is related to the units of v and c. Now vdv/dc has the dimensions of an acceleration; and the magnitude of a unit of acceleration is always equal to the quotient of the square of the magnitude of the unit of velocity by the magnitude of the unit of length, provided these units are units of some one derived system, and their magnitudes are expressed in terms of the same units of length and time. Hence our unit of acceleration must be $10^2 \div \frac{3}{4} = \frac{400}{3}$ feet-per-second per second. The scale of *ff*, therefore, considered as giving values of vdv/dc for the various crank positions is $\frac{400}{3}$ ft.-sec. units to a division.

Finally, in employing *ff* as a curve of force, we apply the equation:

$$S' - S = mv\frac{dv}{dc},$$

without any further geometrical construction. It is obvious from this equation that if vdv/dc have the value $\frac{400}{3}$, $S' - S$ will have the value $\frac{400\,m}{3}$. Hence the scale of the ordinates of *ff*, considered as a force curve, will be $\frac{400\,m}{3}$, the value of m varying with the unit of mass in terms of which the mass of the rod is expressed. Also the above equation holds only provided all quantities in it be expressed in terms of derived units. Hence

the unit of force in terms of which the scale of the force curve will be expressed will be the unit of force of the system derived from the unit of mass selected and the units of length and time employed above. Thus, the scale of the ordinates of *ff*, considered as an acceleration curve, having been found, with the velocity and distance scales originally selected, to be $\frac{400}{3}$ ft-per-sec per sec. to a division, if the mass of the connecting rod be 1 cwt. (British) and if we select the pound as unit of mass, the force scale will be $112 \times \frac{400}{3}$ poundals to a division. If we wish the force scale to be expressed in pounds-weight, we must express m in terms of the unit of mass of the gravitational system, viz., 32 lbs., in which case the force scale is $\frac{112}{32} \times \frac{400}{3}$ pounds-weight to a division.

The $S'-S$ curve having thus been obtained and its scale determined, it is easy to obtain the value of S when P is given, by a graphical method. For, as seen above,

$$P\,(p/s) = S',$$

and P being given for all crank positions, and p and s being found from the diagrams similar to Fig. 1, the values of $P(p/s)$ may be found by the ordinary graphical methods of multiplication and division, and a curve of $P(p/s)$ or S' plotted in the same way as the above curves. Then the excess of the length of any ordinate of the S' curve over that of the corresponding ordinate of the $S'-S$ curve, proper regard being had to sign, will be the length of the corresponding ordinate of the S curve.

Sometimes instead of requiring to find the amount by which the effort on the crank-pin, S, is diminished by the inertia of the connecting rod, the "nett forward piston pressure," P, being given, we have to find the amount by which this latter force must be increased in order that the effort on the crank-pin may not be diminished by the inertia of the rod. To make this determination additional calculation is necessary. For we have as before

$$P\frac{p}{s} - S = mv\frac{dv}{dc};$$

and therefore if P' be the value of P, calculated on the assumption of a massless connecting rod, requisite to produce a given S,

$$P'(p/s) - S = o.$$

Hence

$$P - P' = \frac{s}{p} mv \frac{dv}{dc} = \frac{s}{p}(S' - S.)$$

If, therefore, the ordinates of *ff* be increased in the ratio of s/p, we obtain a curve giving the values of $P - P'$ to the same scale as that on which *ff* gives the values of $S' - S$. We may obviously obtain the $P - P'$ curve from the $S' - S$ curve, by a process similar to that by which we obtained the curve *v v* from the curve *V V* above.

The portion of the literature of graphical methods which is accessible to me is very small; and I am not at all sure that the above method is new. I have been led to submit it to the Institute by finding, in so recent and so authoritative a work as that of Prof. A. B. W. Kennedy, on the Mechanics of Machinery (1886), a graphical method of solving the above problem which appears to me to be erroneous. Prof. Kennedy obtains the curve *v v* in the way shewn above, and then, after pointing out that it is not what is known as a "velocity curve to a distance base," he proceeds to treat it in the way in which a curve to that kind would be treated in order to obtain from it a force curve, though without justifying this course. He thus obtains a graphical construction for solving the above problem, which is inconsistent with that given above, and which seems to me to give inaccurate results.

IX.—On the Nidification of the Winter Wren in Nova Scotia.—By Harry Piers, *Assoc. Member A. O. U.*

(Read April 11th, 1892.)

Only very few completely identified nests of this common species *(Troglodytes hiemalis)* have so far been discovered by naturalists. The description, therefore, of one in the present writer's possession, may help somewhat toward a more complete account of its breeding habits, of which we at the present time possess but scant knowledge.

For the sake of comparison, it is advisable to give short notes on most of those which have already been collected in other localities. In doing so, I shall mainly notice such as have been summarised by Rev. J. H. Langille.*

Audubon found two nests, each containing six eggs. The first was discovered in the pine woods near Mauch Chunk on the Lehigh River, Pennsylvania. It was placed on the lower portion of a tree-trunk and has been described as a "protuberance covered with moss and lichens, resembling those excrescences which are often seen on our forest trees, with this difference, that the aperture was perfectly rounded, clean, and quite smooth. . . . Externally, it measured seven inches in length, four and a half in breadth; the thickness of its walls, composed of moss and lichens, was nearly two inches; and thus it presented internally the appearance of a narrow bag, the wall, however, being reduced to a few lines where it was in contact with the bark of the tree. The lower half of the cavity was compactly lined with the fur of the American Hare, and in the bottom or bed of the nest there lay over this about half-a-dozen of the large, downy abdominal feathers of our common Grouse *(Tetrao umbellus)*. The eggs were of a delicate blush colour, somewhat resembling the paler leaves of a partially decayed rose, and marked with dots of reddish-brown, more numerous toward the larger end." The other nest was found on the bank of the Mohawk River, New York

*"Our Birds in their Haunts," 1884, p. 282 *et seq.*

State, attached to the lower part of a rock. It differed from the one just described, in being smaller, but was otherwise similar.

DeKay* tells us that his collector, a Mr. Wood, found the species breeding in great numbers near Lake Oneida, New York, in July, and that the number of eggs was from ten to twelve.

A nest with eggs was taken in Eastern Maine by Mr. W. F. Hall, who found it built in a deserted log-hut, among the fir-leaves and mosses in a crevice between the logs. The structure "was large and bulky, composed externally of mosses, and lined with feathers and the fur of hedge-hogs. The shape was that of a pouch, the entrance being neatly framed with sticks, and the walls very strong, thick, and firmly comparted." Its framework had been made of green hemlock, the odour of which was very agreeable.

On July 23rd, Mr. H. D. Minot discovered a nest in the White Mountains, New Hampshire. It was in a moss-covered stump, about a foot high, standing in a dark, swampy forest filled with tangled piles of fallen trees and branches. The entrance to the nest was less than an inch in diameter, and it was covered with an overhanging bit of moss which the bird pushed upward when entering. Within, it was thickly lined with feathers of the Ruffed Grouse. The eggs, five in number, were "pure crystal-white, thinly and minutely specked with bright reddish-brown, and averaged about .70 × .50 of an inch in dimensions."

In 1878 three nests were found by Mr. James Bradbury of Maine. Two of these were under fallen trees, at the roots, and the remaining one was sunk into the thick moss which enveloped another prostrate trunk.

From the previous notes we see that the bird, when about to breed, is ready to adapt itself to circumstances, and consequently the position and form of the nest may vary from a "protuberance" on a tree-trunk to a snug little structure stowed away in some retired and suitable crevice. It is formed of moss with a lining of warm material, such as feathers. The eggs are white, spotted, chiefly near the larger end, with reddish-brown. The generic

*Natural History of New York: Birds; p. 57.

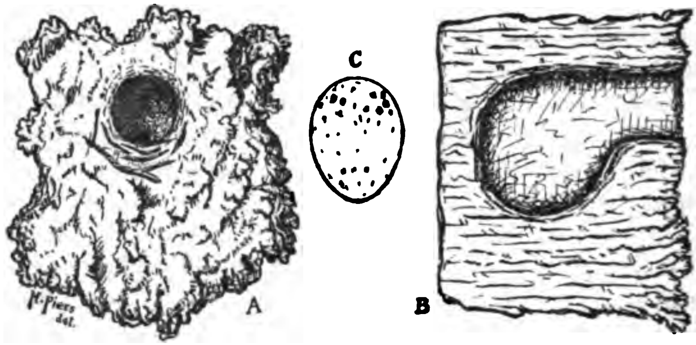
name Troglodytes, which has been given to the Wrens, signifies 'one that creeps into holes.' It has been so applied because of their custom of nesting in cavities and other out-of-the-way nooks. This secretive habit seems to be common to both the old and the new-world forms, and largely accounts for the scarcity of facts relating to the nidification of the species at present under consideration.

I shall now speak of the nest and eggs in my own possession, of which a full description will be given.

They were found, about May 11th, 1891, by my brother while fishing at Kidston's Lake near the Rocking Stone, Spryfield, Halifax County. One of the parent birds was then seen at the nest. On May 22nd I examined them and took one of the eggs; on which occasion the bird was again observed. Another visit was made on the fifth of the following month (June). Several times I saw the bird enter and leave the nest. It was probably the female. When disturbed, she hurried away without the slightest noise, usually flying to the ground and rapidly hopping out of sight, as though ashamed of her little home. Nor did she seem very anxious about its security while we were occupied in examining it. This was very different from most other birds, which keep diligent guard over their eggs, of whose safety they seem extremely solicitous, and in defending which they often exhibit great instinctive pugnacity. At one time the Wren proceeded toward the outer end of a dead tree-trunk, where she captured some larva, and then whilst retaining hold of the animal with the bill, killed it by several vigorous blows directed against the wood. These strokes could be distinctly heard, although the bird was a rod or two away. Such an incident illustrates the want of maternal concern which has just been noted. Once while she was within the nest, I placed a landing-net over the entrance and held her for a short time, so as to put the question of identification beyond a doubt.

After observing as much as possible, I cut out a square of the moss with my knife, and so obtained the nest and eggs. It seemed a pity to miss an opportunity of thoroughly examining them, and the bird undoubtedly would again build.

The nest was a cavity in the long moss *(Sphagnum acutifolium ?)* covering the perpendicular face of a granite boulder.* The latter was embedded in the sloping bank of the lake, the water of which came within a yard or two of its site. The vicinity was wooded. On examination, I found that the whole of the moss containing the nest was kept *constantly saturated*



NEST AND EGG OF WINTER WREN.

A. Moss containing nest, detached from surrounding portion ; 1-4 nat. size.—B. Section of A ; 1-4 nat. size.– C. Egg ; nat. size.

with water which came from the bank above and flowed over the top of the stone, thence passing through the moss, from which it dripped at the base. The little cavity was therefore surrounded by a wet mass which must have kept the eggs at a very low temperature. How the bird could maintain sufficient warmth to hatch them, is a mystery to me, especially as she seemed to be of a gadding disposition.

This damp condition of the nest I consider a peculiar circumstance. The Wrens, however, are noted for their eccentric ideas as to the proper situation for a nest. The European species *(T. vulgaris)*, which is closely related to the Winter Wren, and which in fact was confounded with it by some early writers, has been known to build in such a curious place as the body of a hawk which had been killed and nailed to the side of a barn, and likewise in the throat of a dead calf, in the interior of a pump,

* The nest was about a foot from the ground at the base of the stone.

and other situations which seemed to be entirely unsuited to such a purpose.

Very few materials were transported to compose the nest. The bird had simply formed a short cylindrical passage in the moss *in situ*, and made an enlarged cavity at the inner end, wherein were deposited the eggs. This was sparingly lined with a small number of feathers together with a few bits of grass and fibre. Several pieces of twigs were neatly set in the outside lower part of the entrance, probably for the purpose of strengthening that portion.

As before mentioned, I had taken one of the eggs on May 22nd, and on the day now in consideration (June 5th) it was found that there were five still remaining, making a total of six. A description of the one taken on May 22nd, is typical of them all. It is white, speckled with reddish-brown; the spots round the larger end being of greater size than elsewhere, and they also enlarge, but very slightly, at the smaller extremity. These specks and spots are mostly somewhat irregular in form, being occasionally oblong or like very short dashes. Size of egg, .64 × .51 of an inch. In another specimen the specks are more decided in colour, and there are some fair-sized spots on the sides as well as the ends.

I trust that the descriptions I have given of this nest and eggs, will serve to show any slight difference from, or similarity to specimens from other places. For this purpose notes from new localities are always desiderata to the generalizing naturalist.

X.—The Fletcher Stone.—By K. G. T. Webster, B. A., Yarmouth, N. S.

(Read 11th January, 1892.)

The Fletcher Stone was found by Dr. Richard Fletcher, a retired army surgeon, on his place near the town of Yarmouth. As nearly as I can ascertain, this was eighty years ago*. Soon afterwards copies of it were sent to savants in different parts of the world, and many theories formed to account for its curious markings. Sir Daniel Wilson received a fac-simile of the inscription in 1857 from Dr. G. J. Farish; and he refers to the stone in his "Prehistoric Man;" and, at greater length, in a paper read before the Royal Society of Canada in 1890. The N. S. Historical Society has had the stone under consideration, and they also forwarded a copy to the learned President of Toronto in 1886. It was the subject of a paper by Mr. H. Philips, before the American Philosophical Society in 1884. A Yarmouth *Herald* of July, 1884, gives a cut of it; and the New York *Herald* for July 27, 1890, has a copy of the inscription accompanying an article which claims for it Carian origin.

The stone is the common rock known as county stone,—quartzite, I presume. It measures about 31x20x13 inches; and has been split from the parent boulder where a thin vein of quartz traversed it. One side is thus left quite level, and tolerably smooth, excepting for a bit of raised jagged edge. A good idea of its appearance may be obtained from the cut which illustrates Sir Daniel Wilson's paper, in Vol. VIII of the Transactions R. S. C. The plaster-paris cast which I have present shows the exact size and shape of the characters. They are thirteen in number, and extend in a line almost across the flat side of the stone. The end of the inscription is shown by a faint period. One can notice how the characters become shallower towards this end, as if the cutter was getting tired; and larger, by a natural tendency.

*Sir Daniel Wilson in his paper "Vinland of the Northmen," Vol. VIII of the R. S. C's Proceedings and Transactions, quotes Dr. Farish as writing him in 1857, that the stone had then been known upwards of forty-five years. The present owner of the stone, Samuel Ryerson, Esq., corroborates this.

There has been some confusion as to the exact place where the stone was found; and I shall therefore describe it particularly. It was on the west side of Yarmouth Harbour; at the foot of a hill on the east side of a small cove, into which runs a stream from a marsh about a mile long, called the Chegoggin Flats or Salt Pond. An old road, traces of which may yet be seen, used to run around the foot of this hill, and cross the bar at the mouth of the stream. The stone lay a few steps to the east of the road*, on the north-west slope of the hill. I have by me a rough sketch of the harbour, which shows the place clearly.

Of course many conjectures have been made to account for the extraordinary inscription on the stone. It has been ascribed to everybody who could have been in Nova Scotia, from the Phœnicians to Bill Stumps.

The writer of the article in the *New York Herald* holds that the Fletcher Stone inscription, as well as many others which have been found along the Atlantic coast, is the work of Carian sailors in the Phœnician navy, who visited America, it is supposed, seven or eight centuries before Christ. But we possess almost too few data to judge of this hypothesis; the Carian alphabet that we have is only a tentative one, and the cuttings on the Yarmouth stone do not agree with this much better than with the Runic.

Neither our Indians nor the Esquimaux, who may once have inhabited Nova Scotia, are known to have any inscriptions at all similar to this; and we may, I think, dismiss them from our discussion. The cuttings are not smooth grooves in the stone, but appear to have been made—to use Dr. Farish's words—"with a sharp pointed instrument carried on by successive blows of a hammer or mallet, the effect of which is plainly visible." Probably only a metal instrument could have been used in this way and with the effect which we see; and this precludes the possibility of Indian or Esquimaux origin. The fact that the stone shows the same peculiarity now that it did when Dr. Farish wrote, thirty-five years ago, is worth noting; for it proves that the inscription has not been seriously tampered with—that, in spite

*Mr. Chas E. Brown.

of the cleaning out with spikes and the paintings it is said to have received at the hands of eager photographers, it is still the same.

The theory which ascribes these glyphs to the Northmen is less improbable than this, and particularly tempting. Soon after it was known beyond reasonable doubt that the Northmen discovered America five centuries before Columbus, which may be said to have been established by the Society of Northern Antiquaries in 1837, this inscription was affirmed by many to be their work. Mr. Henry Philips, in a paper read before the American Philosophical Society in 1884, completed this Norse hypothesis by giving a translation of the inscription, which he pronounced to be genuine Runic. Mr. Philips made it—*Harkusson men varu,* "Haka's son addressed the men." He found the name, or one very like it, in the account of Thorfinn Karlsefne's expedition (1007), in which very expedition they came to a place where *a frith penetrated far into the land. Off the mouth was an island past which ran strong currents; which was also the case further up the frith.* Now Yarmouth Harbour answers in some degree to this description; and if no serious objections could be made to Mr. Philips' translation, one could hardly help accepting the Norse hypothesis as something more, as fact; and certainly this would be an eminently satisfactory explanation. But unfortunately most serious objections are taken to this translation—indeed I do not know if it is endorsed by any Norse scholars of repute. On the contrary, Sir Daniel Wilson says of this inscription—"it neither accords with the style or usual formulas of Runic inscriptions, nor is it graven in any variation of the familiar characters of the Scandinavian futhork." And if the translation does not hold, the identification of Yarmouth as the place mentioned goes for nothing, for it requires considerable straining, as we shall see, to make Yarmouth Harbour agree with the description; and there are scores of places both north and south of it which would answer far better.

Mr. Geo. S. Brown in his history of Yarmouth,* supporting Mr. Philips' hypothesis, attempts to show in greater detail from the narratives of the Northmen's voyages, the probability of their

*Yarmouth, N. S. A Sequel to Campbell's History, Boston. Rand Avery Co, 1889, pp. 17-24.

having landed at Yarmouth. Mr. Brown identifies both the place in Vinland where Lief wintered, and the frith or fiord of Karlsefne's—two different places—as Yarmouth! We know that they are two different places from the descriptions; and because we are told that a party set out from Karlsefne's fiord, and went north to find Vinland, Lief's wintering place.*

In order to examine them, it will be necessary to take from the narratives what gives us any clew to the locality.† Lief (c. 1000) sailed from Greenland to Helluland, which was a snowy country with a plain near the shore, and mountains further inland; thence seaward to Markland, a flat wooded country with stretches of white sand; then seaward again for two days with the wind northeast, to an Island which was north of the mainland; they sailed west through the sound, past a cape jutting north, to a place where there were flats at low tide; here a river from a lake a short distance off emptied; they took their vessel up the river to the lake and wintered there; this place they named Vinland. Another account says that the Island was east of the main, and that they sailed east past a cape jutting northeast. Mr. Brown takes an account the same as this latter, excepting that it gives their course as west instead of east, like the first account. "Lief," says Mr. Brown, "shaped his course from Newfoundland, last seen by Biarne; then passing, through the straits of Belle Isle, he discovered Prince Edward Island; thence, standing out to sea to the eastward of Cape Breton he came to the Gut of Canseau, which he entered; and thence sailed westward along the coast, wintering perhaps at Yarmouth."‡ Let us look at this. Granting that Helluland may be Newfoundland, and not Labrador, yet passing through the strait of Belle Isle is certainly very little like putting to sea, as the narratives say they did; and it would suppose the Northmen to have turned right back on their course; unless indeed they had happened to strike exactly at the mouth of the narrow strait, which is improbable. Markland is taken to be Prince Edward Island, tho' we are not told that it is an island: and it would as likely

*Laing's Sea Kings of Norway, I. 6. Longman, Brown, Green and Longman, London, 1844.
†Taken from Laing's Sea Kings of Norway. I. 5.
‡The Sequel, p 21.

have been mentioned to be one as Cape Breton. From here the Northmen put to sea again, and sailed two days with a northeast wind, till they came to an island; i. e., according to Mr. Brown's interpretation, they sailed away from P. E. I., to the eastward of Cape Breton—almost a northeasterly course, and one not apt to be taken in a northeasterly wind by Viking ships. From the eastward of Cape Breton, the Northmen are said to have reached Yarmouth, *via the Strait of Canso*—to say the least, an extremely improbable route. We must admit the inadequacy of this attempt to identify Yarmouth or its neighbourhood as Lief's Vinland.

The accounts of the voyage of Thorfinn Karlsefne (c. 1007) tell us that he sailed past Helluland and Markland; and yet southwest a long time with the land to starboard, till he came to a place where a frith or fiord penetrated far into the land. There was an island at the mouth of the frith, and strong currents ran around it; this was also the case further up the frith. This place Mr. Phillips and Mr. Brown identify with Yarmouth Harbour, on very insufficient grounds. To begin with, Yarmouth Harbour is very small—about two miles long; and nothing but a narrow, crooked channel when the tide is out. This would hardly seem to the Norsemen, used to the grand fiords of Norway and Iceland, as penetrating *far inland.* That it once extended several miles further, to the present Chegoggin River, as Mr. Brown assumes, is the merest supposition; and it would not even then make a respectable fiord. The island around which currents swept is supposed to be Bunker's Island, at the mouth of the harbour. Now Bunker's Island, as a glance at the map will show, is more peninsula than island, and the only place about it where there is any current is at the west end, where the tide waters flow in and out of the harbor. Even here, it is trifling—no more than a fisherman can row his dory against; and compared to that in many Nova Scotian harbours, and to the whirling eddies of the Tusket Islands, a few miles distant, and through which the Northmen would probably pass to reach Yarmouth, it is nothing. The current mentioned as existing further up in the frith is taken to be that at the mouth of the stream which flows

from the Chegoggin Salt Pond—a very insignificant and intermittent one; and which might not exist at all, if the harbour were stretched to what Mr. Brown gives as its former extent. One circumstance mentioned in the narratives, however, shows pretty conclusively that Yarmouth Harbour could not have been Karlsefne's fiord: a party, sent in a northerly direction from here to find Vinland, Lief's wintering-place, had got a considerable distance on their way, when a westerly gale blew them over to Ireland. Now if one went northerly from the mouth of Yarmouth Harbour, he would go up the Bay of Fundy; and a west wind would only drive him onto the Nova Scotian side of the Bay. And Ireland is not west of Yarmouth; but of Labrador, four or five hundred mile further north.

I think, then, we must regard these attempts to show the identity of either Lief's wintering-place, or the fiord, and Yarmouth Harbour, as futile. Instead of the syllogism reading, "It is probable from their narratives that the Northmen were at Yarmouth; the Fletcher Stone inscription can be made to read so and so in Runes; there was a man of like name to one mentioned in the inscription, in the expedition, the account of which renders it probable that they were at Yarmouth; therefore it is very probable that the Fletcher inscription is the work of these Northmen," we should read it—" It is *improbable* from the narratives that the Northmen were at Yarmouth; the inscription cannot be made to read *anything* in Runes, and therefore, whether there was such and such a man or not, it is *very improbable that the Fletcher Stone inscription is the work of Northmen.*"

The next possible authors of such a thing as this inscription in Nova Scotia would be the French, who passed the Forked Cape, Cape Fourchu, in 1604; and who had, before a great many years, a thriving settlement all along the Cheggogin River, only a few miles from the spot where the stone was found. But though possible, it is certainly very improbable that they made the inscription; and we may, I think, dismiss their claim without discussion.

Then, if we reject the claims of the Aborigines, of the Phœnicians, Northmen and French, we must of necessity attribute the inscription to the later English, for it certainly was not made

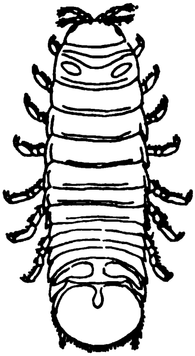
without hands. Of course there are many conceivable explanations for the occurrence of such a thing, all more or less unsatisfactory. The least unlikely seems to me to be—that the inscription was cut either by somebody merely for his own amusement; or by some mischievous fellow who wished it to pass for the work of an ancient or foreign people. This is not a satisfactory conclusion—it was going to a great deal of trouble to cut this inscription simply for amusement; and if it is an intentional fraud why was it not made so that some meaning could be taken from it? If, for instance, it was meant to pass for Runes—of course it could not have been at that date, when it was unknown that the Northmen were ever in America—the fabricator would have taken pains to make good Runes, as in the fictitious inscription found on the Potomac in 1867, where the characters were copied from genuine Greenland inscriptions. But, unsatisfactory and incapable of strict proof as it is, I believe this explanation must be accepted as the most probable.

Illustrating Dr. Murphy's Paper on "Destroyers of submerged Wood in Nova Scotia."

XI.—Supplementary Notes on Destroyers of Submerged Wood in Nova Scotia.—By M. Murphy, D. Sc., *Provincial Government Engineer, Nova Scotia.*

Much has been said and written about the destructive habits of the *Limnoria Lignorum*, or "gribble," as it is usually called by the fishermen in Great Britain. It is one of the most destructive creatures, attacking all woodwork below tide mark. Although its ravages have gone on for centuries it was only made known to naturalists by Dr. Leach in 1811. The living specimens which I place before you this evening have been just taken from their burrows in a piece of a submerged pile from a wharf in Halifax Harbor. The piece of pile was sawn off two feet below the surface during low water at spring tide. It was immediately placed in a bucket of sea water and brought to my office. On its removal from the water the outer soft layers of wood were found to have been burrowed into cells about one quarter of an inch in depth, just deep enough to protect the workers without covering them. I picked them from their burrows with the point of a writing pen, letting them drop into the bottles where you now observe them. You may notice that they are quite active, that they dart forward or backward with equal swiftness and that they are capable of moving rapidly in the water.

I tried to get them photographed in the water, but without success. Fig. 1, on the following page, is reproduced from a drawing by Prof. J. Smith. Fig. 2 is from a photograph by Notman. Their length is 4.3 m.m. breadth, 1.6 m.m.; color in water, light greyish. They are no doubt identical with the *Limnoria Lignorum*, White, and are the same species of crustacean as that first brought prominently into notice by the celebrated Robert Stephenson, who found it rapidly destroying the wood work at the Bell Rock light-house erected by him on the coast of Scotland. Unlike the Teredo, this creature is vegetarian and lives on the wood which it excavates, so that its boring operations, as remarked by Dr. Baird, provide it with both food and shelter



Limnoria lignorum

Enlarged ten diameters.

Fig. 1.

Photograph of Limnoria and Annelide.

Fig. 2.

The Limnoria is aptly described in Chambers' Encyclopædia thus :—" It is only about the sixth of an inch in length, of an ash grey color, with black eyes which are composed of numerous *ocelli* placed close together. The head is broad. The legs are short. The general appearance resembles that of a small wood louse, and the creature rolls itself up in the same manner if seized."

It is found boring in submerged wood along our coast from Florida to Halifax, N. S., and the Gulf of St. Lawrence. It occurs above low water mark, but does not usually live far below that line. It has however been found by Professor Verrill at a depth of ten fathoms in Casco Bay, and was dredged by the United States Fish Commission at a depth of 7½ fathoms in Cape Cod Bay, Mass., in the summer of 1879. It is abundant, according to European authors, in many localities on the coast of Great Britain and in the North Sea. *L. uncinata*, Heller, from Verbasca in the Island of Lesina, Adriatic Sea, appears to be the same species, as the differences pointed out by Heller do not really exist, but were doubtless suggested by the incorrect figures that have been published representing the uropods with rami

composed of two or more segments. *Limnoria* is said also to occur in the Pacific Ocean, and from its habits might be expected to have a wide distribution.

In my paper on the ravages of the *Teredo Navalis* and *Limnoria Lignorum* in Nova Scotia, on piles and submerged timber, (see pp. 357–376, vol. V, Trans. N. S. Institute of Natural Science, 1881-2), I brought this subject more prominently before you. My remarks this evening are intended to supplement that paper with such information as I have since obtained respecting this insignificant in appearance, yet destructive little isopod. For here in Halifax Harbour where they are so destructive as to destroy the piling of our wharves, or at least most of them, in a period of eight or ten years, and have in seven years destroyed the piles of the wooden railway bridge across the Narrows of our harbor, involving an expenditure of many thousands of dollars, there are not many questions of greater local importance to the Engineer than that of devising some means whereby their attacks may be arrested or prevented. The *Limnoria* has also been charged with the grave offense of attacking the gutta percha of submarine telegraph cables, with damaging tarred ropes, used for mooring boats, and with the destruction of fishermen's weirs, as well as that of destroying all sorts of timber.

We can only remedy these destructive operations by a precise knowledge of the causes that produce them, such knowledge as may enable us to check or at least to mitigate some of these undesirable consequences.

In the Bay of Fundy where the water is clear, free from silt and transparent, the *Limnoria* is active and very destructive. Up the Bay where the tide during the ebb digs deep into the muddy flats thus discoloring the water and making it mucid there is no *Limnoria*.

In the Annapolis Basin they are active; at the head of the bay, where the water is muddy, they are not to be found. In like manner in Halifax Harbor where the water is clear they are active. At such places as are polluted by a discharge of sewerage into the harbor there are no Limnoriæ to be seen. We account

for their absence in such localities as we have named, by reason of the muddy or unclean water leaving a deposit of silt, in their cells or burrows, and in this way sealing them up so as to destroy the tenant or make the cell uninhabitable. It is further noticeable that any piece of timber partially covered by mud, slime or algæ is exempt from these attacks, although timber in the same place not so covered is being destroyed by them.

From these observations one might infer that some external application such as cement, lime bitumen or coal-tar, if repeated as required, would arrest their ravages if not end them. These conjectures, of course, require confirmation, though they seem not improbable. I may mention, however, that a solution of lime will not kill the *Limnoria*, immediately. I have had them in a glass containing a strong solution of lime for two days and some of them then seemed active.

One method which is used to avert their destruction is to cover the piles or submerged wood-work with copper or zinc sheeting; but this covering is so expensive that it is not generally employed. It is an important practical problem to determine some cheap, ready and effective method or some means whereby we can approach nearest to a cheap and practical method of preventing the ravages of this little pest.

In Nova Scotia we suffer more from the ravages of the Limnoria than we do from the Teredo, not because the crustacean is more destructive than the mollusc, but because the habitat or region of the Limnoria covers the littoral waters where most of our wooden structures are to be found. Wooden wharves or wooden bridges along the Bay of Fundy and from there along the Atlantic coast as far as Whitehaven, suffer from the Limnoria while the location of the Teredo is further east and north. The zone of the Teredo's operations begins about Musquodoboit Harbour. From there to Whitehaven the work of both borers may be traced; and in some intermediate places both may be observed at work on the same stick. There is no neutral ground between them. Their domains overlap for a few miles, each of the little borers becoming less abundant as we advance farther

into the territory of the other. The reason that these destructive creatures cannot thrive on the same ground is quite apparent. The Teredo enters the wood in the embryonic stage through an aperture having a diameter of one-quarter to half a millimetre only, which enlarges little by little until it reaches a diameter of five millimetres or more. This diminutive entrance protects it from its enemies the Annelides. If the opening is enlarged by the exterior burrowing of the Limnoria, the Teredo becomes a prey to its enemies and cannot exist. Both borers may be found on the same pile at work at the same time, but such are not the fittest conditions provided by nature for their growth and development.

Since the researches of Quatrefages and Kater and the report of the Dutch commission on the Teredo and its depredations, nothing more reliable as to fecundation of eggs, development and expulsion of young, has been added. Quatrefages tells us that the eggs pass through a series of modifications, such as is met with in the examination of all animals, that in the third phase of development the bivalve shell is formed, the foot appearing on the outside, that the embryo possesses the faculty of locomotion, and that the development is very rapid, four days only being required for the acquisition of full equipment for living in wood. Kater observed them in large numbers on the surface of wood towards the end of June and by the 15th of July he found them in the interior, in the form of perfectly developed Teredos.

They enter the wood thus in small openings which, as we have before remarked, are necessary for their protection as well as, probably, for their growth and manner of sustenance. With such information before us and with the knowledge, from my own observations, that they seldom, if ever, pass from one piece of timber to another, I was led to think that a pile made of boards with a thick coating of tar, or white lead, between them, to protect the inner leaves from the attachment of larvæ or the penetration of the fully developed teredo itself, might arrest their depredations, or perhaps, prevent them from entering further than the outer covering.

Reasoning thus and wishing to try the experiment suggested, I had four piles constructed from hemlock and spruce boards. They were formed, first, by a core 4 x 4 in., and then by boards prepared through submergence in a bath of coal tar, then securely fastened, one by one, until the built pile attained the dimensions of 12 x 12 in. The piles were then hooped and shod with iron, and were driven, close to the Little Bras d'Or bridge, at one of the outlets of the Bras d'Or lakes (tidal waters) Cape Breton. These piles, so formed, could well stand driving under a 16 cwt. pile hammer. They were placed in position in November, 1889, and examined in September, 1890. The teredos had completely riddled the outer board and in some instances had entered the next board to it.

In July, 1891, they were again examined, when they were found to have penetrated to the third board, the two outer boards having been destroyed and the third perforated. I exhibit a section of the pile. You will notice that the outer board is completely eaten away, scarcely any part of it being thicker than a leaf of packing paper. You can by merely an impress of the fingers rub it off in small leaflets. Still, it is evident that it was partially, if not totally, destroyed at the point where the entry was made to the second board before the entry was effected. In like manner the second board was destroyed before an entry at assailable points to the third was effected.

In the same place, not 100 yards from where these experiments were tried, creosoted piles obtained from Messrs. Eppinger & Russell, Brooklyn, New York, have been driven for over five years, and there is not yet the slightest sign of a teredo having entered any one of them. Essential oil of creosote impregnated into such woods as are adapted to the purpose and treated in such manner, as is being done by Messrs. Eppinger & Russell, will, in my opinion, assure a long duration.

The Teredo requires a clear, pure, salt water. It has often been remarked, that piles placed in dirty muddy water or in the neighbourhood of sewerage discharge are exempt from its attack. From these observations one is led to believe that where there is

no current a strong application of a solution of common lime applied in the months of June, July and August, whilst the expelled ova are undergoing development, might prove effective.

In such places as the Bras d'Or Lakes or in land-locked harbours where the lime would not be immediately carried away by a current, the experiment might be worth trying. An application of a barrel of lime dissolved in about eight or nine barrels of water and poured around the piles of a wharf might be tried, or a stronger solution if considered desirable, or still better, if forced around each pile through a hose and nozzle with an ordinary force pump.

I conclude with some notes on the effect of current on the ravages of *Limnoria*, communicated to me in January, 1892, by Mr. W. B. McKenzie, C. E., of the Intercolonial Railway Office, Moncton, N. B. His observations were made on piles of the Intercolonial Railway Bridge across the Narrows of Halifax Harbor, and are as follows:—

"Hemlock piles driven seven years ago, wlth bark on, into a hard gravel bottom with boulders, in salt water, 55 ft. in depth, where the tide rises 6 ft. and the surface velocity is 2½ miles per hour, were found to be worm-eaten from the surface of the ground upwards about ten feet, as shown on the accompanying photograph (reproduced in Plate II.) No. 1 pile appears not to have entered the ground but probably rested on a flat boulder No. 2 pile penetrated 1½ ft. No. 3 pile penetrated 3¾ ft. The rate of destruction averages $\frac{4}{10}$ of an inch per year, reducing the diameter of pile $\frac{8}{10}$ of an inch per year. As it has heretofore been asserted, and is a generally accepted opinion that the Limnoria works at extreme low water only, or thereabout, the discovery was surprising that, in this case, no damage of any consequence was done at this point, but that its operations were confined to the bottom part of the pile, being greatest at its ground line and decreasing upwards for a distance of about 10 feet.

"I can only account for this on the hypothesis that the current being about 2½ to to 3 miles per hour at the surface, the Limnoria found it easier and more convenient to work down near the bottom, where the current was probably much less.

"In large rivers (to which the "Narrows" may be compared) the bottom velocity is much less than the surface velocity. Du Buat gives an approximate rule for finding the mean and bottom velocity thus:—If a be the surface velocity, b the bottom velocity and y the mean velocity, all in inches per second, then $b = (\sqrt{a} - 1)^2$ and $y = \frac{1}{2}\left(a + (\sqrt{a} - 1)^2\right)$. According to this, if the surface velocity at the "Narrows" is 2½ miles per hour, the bottom velocity will be 0.85 miles per hour and the mean velocity 1.54 miles per hour.

"I think we may conclude that in a current having a bottom velocity of about 3 miles per hour, the operations of the Limnoria would be much retarded, if not wholly prevented."

Members of the Institute, and Societies in correspondence with it, would confer a great favor if they would send to the Council, for distribution to Scientific Institutions whose sets of the Institute's Publications are incomplete, any duplicate or other spare copies which they may possess of back numbers of the Proceedings and Transactions. They should be addressed: *The Secretary of the N. S. Institute of Science, Halifax, Nova Scotia, Canada.*

THE

PROCEEDINGS AND TRANSACTIONS

OF THE

Nova Scotian Institute of Science,

HALIFAX. NOVA SCOTIA.

SESSION OF 1893-94.

VOLUME VIII,

BEING VOLUME I OF THE SECOND SERIES.

The First Series consisted of the Seven Volumes of the Proceedings and Transactions of the Nova Scotian Institute of Natural Science.

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PROCEEDINGS

OF THE

Nova Scotian Institute of Science.

SESSION OF 1893-4.

ANNUAL BUSINESS MEETING.

Province Building, Halifax, 8th November, 1893.

M. MURPHY, D. SC., C. E., *President, in the Chair.*

The minutes of the last annual meeting were read and approved.

The PRESIDENT addressed the Institute, reviewing the progress of the past year.

On motion of Dr. J. Somers and Principal P. O'Hearn a vote of thanks was tendered to Dr. Murphy for his services as President during the last three years.

The TREASURER presented his annual report, shewing the Institute to be in a satisfactory financial condition.

The CURATOR of the Library presented his annual report, shewing a continuation of the rapid growth of the last few years.

The following were elected office-bearers for the ensuing year:—

President—PROFESSOR GEORGE LAWSON, LL. D.

Vice-Presidents—H. S. POOLE, F. G. S., and A. H. MACKAY, LL. D.

Treasurer—W. C. SILVER.

Corresponding Secretary—PROFESSOR J. G. MACGREGOR.

Recording Secretary—A. MCKAY.

Librarian—MAYNARD BOWMAN.

Councillors without office:—M. MURPHY, D. SC., E. GILPIN, LL. D., A. P. REID, M. D., J. SOMERS, M. D., H. PIERS, F. W. W. DOANE, C. E., and A. ALLISON.

Auditors—S. A. MORTON, M. A., and M. SHINE.

FIRST ORDINARY MEETING, Province Building, Halifax, 8th November, 1893.

DR. MACKAY, VICE-PRESIDENT, *in the Chair.*

Inter alia,

Professor J. G. MacGregor read a paper entitled : "On the Isothermal and Adiabatic Expansion of Gases."

SECOND ORDINARY MEETING, Province Building, Halifax, 11th December, 1893.

The PRESIDENT *in the Chair.*

Inter alia,

Dr. J. Somers read a paper entitled : "Notes on Native Forms of Juniperus and Lanius Borealis."

Principal Marshall, of Richmond, N. S., made a statement of facts with regard to what appeared to be a shower of worms. He said :—

In the spring of 1890, while residing in Middleton, Annapolis Co., I observed one morning after a shower of rain with high wind from the south-east, that there were about two dozen earth worms in a molasses cask which was standing so as to catch the water from a spout that was connected with a trough placed under the eaves of the barn. I had been to the cask for water several times the day before and had not noticed them there, and I felt sure that they could not have crawled in over the side of the cask, for it was 3 ft. 8 in. high. I got a ladder and climbed to the roof to see if there was any dirt in the trough in which they might have lived until brought down by the rain. I did not find any earth in which they might have lived, but I found more than a dozen worms sticking to the roof with one end dried fast to the shingles as if they had struck against it with some force and had been partly crushed and killed. When I came down from the roof I examined the wall and found several worms crushed against it. They were on the middle and western part of the wall and roof. I could not discover any on the eastern end, nor on other buildings standing on that side of the barn. There were no buildings at the western end, so I could not determine where, in that direction the limit would have been, if there had been a wall to receive them. As it was they were scattered over a wall about fourteen feet square, and over the side of a roof fourteen feet long and twelve wide. The soil to the south of the barn is sandy and nearly all covered with a grass sod. There were no large trees near the building.

The PRESIDENT, Prof. G. Lawson, read a paper entitled : "Remarks on Some Features of the Kentucky Flora."

On motion of Prof. J. G. MacGregor and Dr. A. H. MacKay the following resolution was passed :—*Resolved,* That the Council be instructed to address a memorial to the Dominion Government setting forth the advantages of low postal rates on natural history specimens, both in facilitating the progress of the variious departments of natural history and in making known the natural resources of the country, and praying the said Government to take steps to secure throughout Canada and the postal nnion the same rate of postage on scientific specimens as is at present provided for in the case of samples of merchandise.

THIRD ORDINARY MEETING, Provincial Museum, Halifax, 8th January, 1894.

The PRESIDENT *in the Chair.*

Inter alia,

Dr. E. Gilpin, Deputy Commissioner of Mines, read a paper entitled: "On the Nictaux Iron Ore Field."

F. W. W. Doane, C. E., read a paper entitled: "On the Operation of the Kennedy Scraper, and the Cause of Recent Failure."

FOURTH ORDINARY MEETING, Provincial Museum, Halifax, 12th February, 1894.

The PRESIDENT *in the Chair.*

Inter alia,

The PRESIDENT, Prof. G. Lawson, read a paper entitled: "On the Botanical and Commercial History of Nova Scotia Foxberries."

A paper by G. H. Cox, B. A., entitled: "List of Plants Collected in and aronnd the Town of Shelburne, 1890-93," was read by the President.

FIFTH ORDINARY MEETING, Province Building, Halifax, 12th March, 1894.

The PRESIDENT *in the Chair.*

Inter alia,

A paper by Principal A. Cameron, of Yarmouth, N. S., entitled: "Notes on Venus,—Morning and Evening Star at the same time," was read by the Secretary.

A paper by Mr. F. J. A. McKittrick, of Kentville, N. S., entitled: "On the Measurement of the Resistance of Electrolytes,"—and containing the results of a series of experimental observations made in the Physical Laboratory of Dalhousie College, was read by the Secretary.

A paper by Mr. D. M. Bliss, Am. Inst. Elec. Eng., entitled: "The Coming Development of Artificial Illumination," was read by the Secretary. The following is an extract from this paper :—

"While a great advance in artificial illumination has been made in the direction of convenience, brilliancy and flexibility, yet it would be hard to find a branch of applied science in which so little improvement in efficiency has been made. And no process is so wasteful of precious energy as this we are now considering.

To the unreflecting mind it would seem that the principle involved in the production of light by the wavering flame of the tallow dip is very different from that brought into action in the electric light, arc or incandescent; but a little thought will serve to convince one that the principles involved in both cases are the same, and indeed the first rays that burst on the astonished gaze of some ancient investigator as he lit the first torch, proceeded from the same source as

those in the less unsteady but more expensive illumination of the "fin de siècle age.

In the tallow dip we have a crude retort, producing hydrogen which while burning raises to a white heat, the minute particles of carbon set free in the action of combustion, and by far the greater part of the potential energy present is wasted in producing carbonic acid and water or in the form of heat waves, leaving but a small portion of energy to be converted into light waves. The same action of course takes place in the oil or gas light, the advantage in the latter, from an economic point of view being the production of the carbon-charged Hydrogen at a central point (the gas house) where a given amount of gas can be produced under much better conditions than can be obtained in the numerous and tiny individual gas retorts of the candle or oil lamp.

In an electric light whether arc or incandescent, the principle remains the same and it is not the electric current we see but highly heated carbon, and the energy necessary to heat the carbon points or filament to the proper illuminating point is obtained from the coal under the boilers of the electric light station through the medium of the rapidly revolving wires in the dynamo cutting the unseen but all powerful lines of force of the magnetic field, and not from a direct chemical process as in the other examples of light.

Now the modern dynamo, as a machine for the conversion of mechanical into electrical energy, is a most efficient apparatus, and usually returns in the form of electricity, 90 to 95 per cent. of the mechanical energy put into it, a result we may well be proud of when it is considered that with the most efficient steam plant not more than 5 per cent. of the energy possessed by the burning coal is converted into mechanical energy in the engine; and as regards the systems of distribution, the loss is not, or need not be, more than 5 to 10 per cent. in transmitting the electrical energy to the points of conversion.

And so we find that here at the point of conversion into light (or the lamps) the greater part of the waste takes place; and as there is not the same chemical action in this light as in the oil or gas flame, we do not find this waste in the form of carbonic acid or water, but almost wholly in heat waves or invisible and therefore useless radiation. Now so long as we utilize carbon as the source from which to obtain light so long will we have this waste of energy in heat, as heat alone, whether it be furnished by the gas flame or electricity, will produce (in carbon) the necessary molecular action resulting in light waves. So it seems probable that we shall employ other processes and proceed on new lines before any great advance can be made in illumination.

In the light of the future, energy (probably electrical) will be converted into luminous waves with a loss not exceeding, say, 5 to 10 per cent. in heat; the light will be practically cold; and the power now required for one 16 c.p. lamp will give us twenty. In looking for an example of a light of this character we naturally think of the fire-fly and glow-worm, both of which may be said to be good examples of a perfect light, at least as far as efficiency goes. Careful tests have been made on the light emitted by the fire-fly, and the results show that it is practically heatless, less than 2 per cent. of the total radiation being in the form of heat waves. It is true that the secret of its production has not yielded to our tests, but we hope that, like many of nature's formulæ, it will be solved, and the

result attained after careful and persistent investigation ; and the fortunate individual who succeeds in penetrating her laboratory and secures the formula for heatless light will win fortune and undying fame.

Another line of investigation which looks inviting is that of phosphorescence and storage of light waves as exhibited by calcium sulphide or luminous paints ; and it is within the range of probability to suppose that a luminous compound will be discovered that will store up the rays of the sun and return them to us when needed at night. not in the feeble glow of the luminous match safe, but with a brilliancy sufficient for all purposes of illumination.

Those who have witnessed Tesla's experiments at the World's Fair will remember the particularly brilliant effect produced when the talented experimenter held in his hand a large glass tube containing but a trace of air and which, though totally disconnected from any visible circuit, glowed with a soft pulsating light of considerable intensity but practically heatless, and we have been told that in the near future we shall light our houses by placing metalic plates on the walls of our rooms and connecting them with a source of a high potential and frequency, and our lamp being simply an exhausted bulb or globe will glow in any part of the room and will need no connection, the light being produced by the rapidly changing electrostatic stress between the walls of the room or plates.

Unfortunately, however, in this method which uses such extremely high potentials and frequencies the ordinary methods of transmission or wiring fail and the effect more nearly approaches the rapidly alternating discharge of lightning in that a metalic circuit is practically opaque, so to speak, to a current of say 1,000,000 volts and the same number of alternations. The self-induction of such a circuit with currents of moderate potential and frequency would be practically nothing, but is something enormous with the above pressure and frequency, and so far as we can see this system if it attains to any degree of perfection will have a very limited field from this effect alone, to say nothing of the severe dielectric stresses.

Whether electricity will play an important part in the light of the future or not is a matter of speculation, and it would not be strange if the coming system were largely a chemical one, though electricity will no doubt be the form of energy used to the points of conversion. However, in any case our present electric light plants will not go out of existance, but will fully occupy the field they are only now entering, for the distribution of power and heat for all purposes.

In conclusion, it may be said that no field is so rich and none so pregnant with good possibilities, but the problem must be worked out on new lines, bearing in mind that any light that depends on carbon as the source of illumination will inevitably consume 90 per cent. of the energy put into the process, in the form of heat, and it matters not whether this energy is supplied by burning gas or the electric current, the results are practically the same, and no great improvement can be obtained till we find out how to separate heat and light, or produce either form of radiation at will."

Mr. John Forbes, of Halifax, addressed the Institute on "Some Modern Methods in Manufacturing with certain Analogies suggested by a Partial Study of the Evolution and Nature of some of the Processes Employed," as follows :—

"The question as to what constitutes raw material is one which has frequently been written about and discussed in its relation to political questions of the day, but our mention of the question at this time is not intended or calculated to excite either sympathy or prejudice in any one on account of its political significance. It is sufficient for us now to suggest that no material used in the arts is qualified to serve any very large useful purpose until it has passed through the hands or machines of some of the numerous classes of manufacture. In this, however, we are met by the reflection that man cannot lay claim to exclusiveness in the manipulation (if the use of the word is permissible) of raw materials in order to fashion them into such shapes and conditions as to subserve his comfort or convenience. Perhaps the most that man can claim is the superior ingenuity which enables him to observe the results, defective or otherwise, of past efforts, and improve upon them, or to profit by his observation of results, as the product of what he may thereafter learn to regard as natural laws.

Amongst the first considerations to which we are led by the line of thought now reached is, the great variety of materials which man has thus brought into usefulness, and made available for his comfort and convenience.

Some of these materials he is enabled to use in the state in which nature supplies them to his hand, but far the greater number he has to obtain at the expenditure of a large amount of labor and by the aid of processes, the understanding of which comes very slowly, and to the understanding of which he has to bring large powers of observation, reasoning and experiment.

Several reflections resulting from a desultory consideration of the subject have induced the writer to observe certain seeming analogies between the older and crude methods employed and the refined modern methods now in use, and to regard with interest the seeming inductiveness of the processes and operations which have resulted in our present condition of refinement in some of the branches involved.

I feel, however, that some apology is due to the Institute for trespassing upon its time by presenting a paper which is so retrospective and so historical in its character, but which, if time and opportunity permitted, I have thought might, if the council approved, be with profit divided into several papers, the preparation and presentation of which would probably be both interesting and profitable.

Pre-eminently above all other materials which man has turned to useful account and rendered by his multifarious adaptations, indispensable is the metal iron.

Man's acquaintance, in a measure at least, with some of the uses of this metal may with reasonable assurance be conceded as antedating authentic history, yet its adaptations were unquestionably restricted to articles of small character, consisting very probably of articles of personal adornment and of tools for the working and fashioning of other and softer metals and materials, and weapons of war and of the chase. It is not difficult to frame an interesting and fairly warrantable theory as to the manner of its discovery. The facility with which small masses of iron can be obtained from some of its ores by simply digging a

hole in a bank of earth suitably situated, charging the same with ore and fuel and permitting the wind to blow favorably upon the arrangement so as to fan the fuel to the requisite heat, suggests the accidental production of the metal as the result of forest fires; and the discovery of small lumps which might be found upon the ground,--after the conflagration—would naturally suggest the inference that the metal was the product of the action of the fire upon certain masses of brown earth or ore which might be found upon the ground in the vicinity.

Job 28th and 2nd: "Iron is taken out of the earth, and brass is melted out of the stone."

Deuteronomy 8th and 9th: "A land whose stones are iron, and out of whose hills thou mayest dig brass."

The iron rocks of Elba, Styria and Spain, and the processes employed for the reduction of the metal, are described by writers before the Christian era, the product being exported to other countries, notably to Italy, to be used in the production of tools; but the methods employed were evidently not very reliable and the product not uniform, as historians of the second century complained that the knives, although very hard, were so brittle that the cutting edge splintered off, which was probably due to the inferior quality of the steel of which they were made and imperfect knowledge as to the working of it. I should remark that I can not claim any originality in this paper, not even to researches at first hand from the old writers themselves, but am indebted to well known treatises upon the subject by able writers and investigators.

It seems probable that the grade of the metal, which we know as steel, was known and utilized by the ancients about as early as the purer metal; in fact, we think it not improbable that the different qualities of the ore obtained from different localities governed the uses which were made of the several products. It would seem also that the rude processes employed for the extraction of the metal rendered the resulting material a somewhat uncertain matter, a large part of the metal in the shape of pig metal or cast iron being thrown away with the slag as a product for which, for a very long period, and in fact up to a comparatively recent era, no use was found. Egyptians sculptures antedating the christian era by 1500 years or more, represent workmen or smiths, operating bellows for blowing the fire used in the production of the metal from the ore, or in the subsequent operations of fashioning it into the articles for which it was found to be adapted, and we think it very reasonable to conceive that this recognized means of urging the fire by a forced blast of atmospheric air, directed upon and amongst the molten mass was the initial discovery which might be established as the link, which has connected the crude processes of the ancients with the magnificent achievements of chemistry in its application to modern metallurgy, the analogy being found in the different effects, which were evidently known to the ancients, of so manipulating the tuyeres and blasts of air, at certain stages of the operation as to produce the desired result, at times intensifying the heat and reducing the metal and then if metal of a steely character were wanted enabling the metal, after its extraction from its earthy oxides, to become impregnated with carbon from the fuel.

The processes were without doubt only experimental, and not understood, some

workmen probably operating successfully with some ores and other workmen realizing success from other ores, as their experience had taught them. But in modern times the Bessemer and the Siemens-Martin processes bring about the desired results in a similar although in a more refined manner and with a know ledge of the rationale of the processes involved. It seems rather surprising that the extraction and use of the metal in its malleable character was known for so long a period before its usefulness in the molten and fluid state were recognized. It would seem from the records that among the first uses for which cast iron was found suitable was in the production of cannons, which is stated to have been accomplished in the thirteenth century.

But it seems to have been much later than this before it was learned that the best way to obtain the metal in its malleable condition was to first arrange for its combination with carbon and run it out of the furnace in the shape of pig or cast iron, and then get the purer metal by burning off the carbon by a plentiful supply of oxygen under a forced blast of atmospheric air, and it is, we think, an interesting reflection that for probably thousands of years those engaged in the operations of iron extraction had been frustrated in their efforts by the accidental conversion of the metal into a state which was useless to them, but which really formed part of the correct process for its economic recovery.

Perhaps it may be well quite briefly to re-state some facts in connection with the matter, viz. : There are two general processes by which the metal may be revived from its ores; one is called the direct process, and consists in subjecting the ore to the action of incandescent fuel in connection with a free supply of air, the air being forced in and among the mass by some means for maintaining a continued blast under pressure. This direct process requires that it is shall be discontinued as soon as the ore has given up its oxygen to the carbon of the fuel, at which stage the particles of the metal cohere in a pasty mass of malleable iron.

If now, instead of stopping the operation at this stage, the process is continued, a result will follow which constitutes the first stage in what may be termed the second or indirect process. This result is, that the metal takes up a portion of carbon from the fuel and becomes more easily fusible and thus passes to a molten state, and becomes what is known as pig iron.

If now, a further continuation of the process is maintained, and a constant stream of air is forced over and amongst the mass of molten metal, the oxygen from the air will combine with the carbon in the iron and the metal will again assume the plastic condition of a highly heated mass of malleable or decarbonized iron. The ancients, as before stated, were only acquainted with the uses of the metal in its malleable condition and so of course aimed at its production by the direct process, but, doubtless accidents at times occurred when their aims were frustrated either by too much fuel or too prolonged a continuance of the operation, and so cast or pig metal was the result; but, although probably things were taken for granted with greater readiness than now, yet it is not, we think, attributing too much intelligence to the smiths and metallurgists of old to imagine them as asking themselves how such and such a result could come about, and when, as probably occurred, it was found that the fuel becoming exhausted and the supply of air being kept up the pasty condition of the metal again

ensued, we think it not too much to assume that the chemistry of the subject became a matter of consideration and study. It will of course be borne in mind that many impurities exist in the ore, and are to be got rid of besides the oxygen which seems to be its most intimate friend, but it was not our wish to take the chemistry of the process into consideration, and we propose only to speak of the principal causes of the difference in the constitution of the metal in the three principal characters under which it is known, viz. : as wrought iron, cast iron, and steel. Now, barring the different qualities of ore—that is, the different combinations of the metal with other matters than oxygen as found in different ores—and hence the different qualities of metal obtainable ; the only difference in the three phases of the metal named consists in the different proportions of carbon with which it becomes impregnated either designedly or by accident. It is proper to remark that the fuel used by the ancients, and indeed down to the close of the 16th or commencement of the 17th century was wood charcoal. This gave the early producers a great advantage, as the use of so pure a carbon prevented in a great measure the introduction of other impurities, except as they might exist in the ore itself, to some of which, notably sulphur and phosphorous, the metal exhibits great affinity and great reluctance to separate from. We are here met by the reflection that if no other means of obtaining iron had been discovered except the old method, and the employment exclusively of wood charcoal as fuel, the advance of the world in the magnificent strides of the present century would have been simply impossible, for the forests would not have sufficed to supply the amount of charcoal needed for the purpose.

In consequence of the lack of knowledge of the uses of mineral coal the demand upon the forests of England for the supply of wood charcoal for iron making was so great that in Queen Elizabeth's reign a law was passed prohibiting the extension of the iron manufacture in certain districts.

In consequence of which law efforts were made to use the mine coal, which was then coming into use as a fuel. These efforts were however strenuously resisted by the manufacturers operating with the wood charcoal, and it was only in the early part of the 18th century that full success in the use of mineral fuel[1] in the production of iron was realized.

We must now again revert to the statement already made that the ancients only practised the production of iron by the direct process, but they also at a very early period learned to produce steel, as Aristotle is said to have described the process of making steel in India, and it was without doubt known that ores found in certain localities were adapted to the more ductile requirements of the producers, and other ores to the requirements of the steel makers. However, from the very long time which seems to have elapsed before the production of steel from iron itself, after its reduction from the ore, it would seem to be a fair inference that the rationale of the process was not at all comprehended. The production of steel by the process known as cementation is based upon the readiness with which the metal in a heated state combines with carbon. Now, while it would have been known that certain different conditions of the metal were produced by different manipulations of the fire in which it was produced, yet ignorance of the chemical constituents of fuel and air prevented the compre-

hension of the processes. But we think the process of cementation for converting the soft iron into steel was not very difficult to evolve. The reasoning was comparatively easy, that the iron was in some way affected by the presence of the charcoal when both iron and charcoal were red hot, and the experiment would, we think, be naturally suggested, to try the effect of the combination after the iron had been obtained, had become cold and had again been heated. The process of cementation for producing steel consists in placing bars of soft iron in contact with charcoal in a suitable vessel and luting the joints of the vessel well with a suitable clay to prevent the access of air, the wasting effect of the action of the air upon the metallic iron when red hot, being known by those who were engaged in such occupations as to afford them the opportunity for observation, the effect of air combining with the heated charcoal and thus preventing the carbon from combining with the iron, by its greater preference for combination with the carbon, would have been a lesson upon which a long previous experience would have afforded unquestionable instruction.

After being thus properly luted and prepared, the pots or chests containing the alternating layers of iron and charcoal are subjected to a strong heat from furnaces suitably arranged, and the heat being kept up for a sufficient length of time (some four to eight days) the whole is then allowed to cool, and after being taken out of the pots or boxes, the carbon (from the charcoal and other carbonizing materials) is found to have entered in combination with the iron, which is also found to be covered with small blisters resulting from the expanding effects of the gases evolved in the process of combination.

The iron which has been thus treated is now known as blistered (or blister) steel, and for a long time (or until the middle of the 18th century) this material made from different qualities of bar iron was used for various purposes in which steel was required. It was also learned that steel thus made could be welded to its more ductile cousin, decarbonized iron, and thus tools could be prepared which, in consequence of their combined qualities, could be made hard by tempering the steel part, while the softer backing afforded by the iron to which it was thus united permitted the cutting part to be made harder with less tendency to break or twist out of shape in the process of hardening. Also, as the steel part was more expensive than the iron part, economy was effected in thus not having to make the entire article of the more expensive material.

But as time passed on and the required uses for steel became more numerous, and more exacting as to the character of the steel required, it was found that a more uniform and stronger steel was needed, and as the reasoning powers of man acquired a greater strength for wrestling with the problems afforded by the necessities of the case, and the artizan and the investigator realized that we are "the heirs of all the ages in the foremost files of time," so we think the reasoning became not so very profound which enabled Huntsman to conclude that as iron when combined with carbon fuses at a much lower heat than the purer iron, and, as might be easily reasoned, the blister steel could thus be melted, (an experiment would demonstrate the fact), and as it had been required to exclude the air while making the blister steel, so also it would be needed to exclude, at any rate in a measure, the air from the blister steel when so fused, and also that

this fusing and blending, so to speak, of the mass by mixing it well while in a state of fusion would materially assist in rendering the metal much more uniform. This seems to have been the way in which the change from blistered steel to its more uniform and denser relative cast steel was effected. This improvement is said to have been effected by Benjamin Huntsman about 1740 in a little town near Sheffield. It is said that Huntsman and his family enjoyed an enviable success as steel makers, and as the process employed by them was kept a profound secret their success naturally aroused the cupidity of his less fortunate competitors who were engaged in the productions of those articles, for which this improved steel was especially adapted, and, as the story goes, on a very stormy night when Huntsman and his workmen in an apartment brightly lighted by the fires were employed in these metallurgical operations, a traveller besought permission to enter and escape for a while the inclemency of the weather, and admission having been obtained the stranger lay down upon the floor and soon feigned sleep, but during the operation of melting and pouring the molten steel he "kept his weather eye open" and became acquainted with the secrets of the process.

It is reasonable to assume that a part of the secret lay in mixing with the molten steel fragments of a more highly carbonized metal, such as had been produced by the direct process, and so, from that time on, various improvements were from time to time effected in the composition, adapting it ultimately for the great variety of purposes for which this most indispensable combination of iron and carbon is so eminently useful.

But while these several processes were being developed for the productien of steel, and of different kinds or qualities of steel, adapted to the various purposes for which steel was necessary, the demands for malleable iron in much greater quantities than previously, stimulated continued efforts to cheapen *its* production and improve its quality. One of the most important advances in this direction was made towards the latter part of the 18th century when it was learned that more energetic mechanical agitation of the metal while in a molten state, in the presence of a blast of air, facilitated the decarbonizing process from the condition of cast iron to that of malleable iron, and the operation of puddling was perfected. In this process the molten metal is continually stirred and agitated by the workmen with the aid of a kind of hook or "rabble" so called, and by this means new surfaces and portions of the molten iron are successively exposed to the decarbonizing effects of the stream of air thrown into the furnace while the process goes on. After a while the refined portions of the metal begin to stick together and the workman, with the aid of his rabble, collects together enough to constitute a ball which he pushes to one part of the furnace while he continues the process and gathers together successively ball after ball until as much as possible of the metal has been recovered from the mass of molten slag and scoria which remains in the furnace, this is then drawn off at suitably prepared orifices and the furnace prepared for another charge. These balls or spongy masses of malleable or decarbonized iron, glowing with a brilliant white heat, and dripping with fluid slag or scoria which is contained in their numerous cracks and fissures, are then taken and subjected to the action of powerful squeezers, or sometimes steam

hammers, which acting upon the balls while in the soft and plastic state in which they are taken from the furnace, squeeze out as much as possible of the impurities which are contained in their mass, and they are then passed through heavy roughing rollers and reduced to the shape of a rude bar of a flattened form, say from 6 to 10 inches wide by some 1 inch to 1½ inches thick, called muck bars. These bars, after being allowed to cool, are then cut up into pieces some two feet long and piled one upon another forming a pile some 8 inches deep. A number of these piles are then taken and placed in a furnace where they are again heated to a welding heat, and are then again passed successively through a number of suitably shaped rolls, and so fashioned into bars and adapted for sundry purposes. It must now be noticed that the operation just described and the forming of the mass into bars depended entirely for its success upon the quality possessed by iron, of being plastic at a certain high temperature, and also that at this temperature, called a welding heat, its particles when brought together will cohere, and may, by being pressed forcibly together while at this heat, be formed into a solid mass, but there are sundry exceptions to this result, for instance if some of the liquid slag or other impurities remains between the particles of the metal, or between the surfaces to be united, then the union will not be a perfect one, and a condition of the metal known as "seamy" will result. This seamy condition rendered the metal quite unfit for many purposes, and although very fine results were obtained in course of time by careful management and by refining, as well as by compacting the mass by very powerful mechanical appliance, yet there were some features in the structure of the material which suggested the need of efforts to obtain a metal possessing greater homogeneity.

The constantly increasing demands made upon the metal by very numerous new uses which were found for it also stimulated the thoughts and investigations of the ablest minds. Physics and chemistry joined hands in endeavouring to realize what seemed within the bounds of practicability, viz., to evolve some means of producing an iron which should meet the exacting demands of new inventions, and their application in enterprises of an importance and magnitude theretofore almost undreamed of.

We have noted the difficulty which occurs when impurities, such as are always present in some degree with malleable iron, are contained between the numerous fissures in the spongy mass. It is almost impossible to get rid of them, and the result is they get rolled or hammered into the mass of the metal in the succeeding processes to which it is subjected in the course of its preparation for the market.

In the process of rolling, these impurities become drawn out into fine longitudinal defects, sometimes involving an entire lamina, and sometimes in defects of less extent. As the masses of metal turned out from the furnaces increased in size, so the hammers and rolls required to deal with these masses had to be also increased in size and power, but yet these improvements did not meet the case in furnishing a metal free from the troubles named. Very much ingenuity however was displayed in efforts to improve these tools so as to give a greater economy in the production and also greater freedom from the imperfections complained of.

As it is but a few years, not more than from 30 to 50 years, or less, since some of the more important of these inventions came into usefulness, it is difficult for us to realize how much they have contributed to possibilities that now seem to be so easy of accomplishment.

For a number of years after the art of rolling became known, only two rolls arranged one above the other were used, and in consequence the bar or sheet of metal, after passing through the rolls in one direction, had to be transferred again to the side from which it had passed through, in order to make another pass. This objectionable loss of time was overcome by arranging three rolls superposed, one above another, called three high rolls, and this permitted the passage of the bar or sheet of metal from either side between one pair of the three, no matter on which side the sheet or bar might happen to be. This arrangement not only saved time but caused the metal acted upon to be elongated alternately from each end instead of being acted upon always in one direction.

Another improvement was also made upon the rolls by which while the metal was receiving the effect of one pair of rolls in one direction another pair of rolls was at the same time acting upon it in a direction perpendicular to the plane of action of the initial pair. This principle was only applicable to the rolling of quarilateral or rectangular forms of cross section.

But there was one serious defect which existed in and was absolutely inseparable from all malleable iron which was fashioned into merchantable shapes by the rolling process, and that was the effect produced by the process of rolling upon iron which had been welded up in its mass in the process of production. The effect was, that there was organized and maintained by the rolling process a well defined fibrous structure of the metal, which, while it did not diminish its resistance in a direction parallel to the fibre, yet it very materially interfered with its strength in a direction at right angles to the fibre, and although for many purposes this did not so much matter, yet there were other uses in which this feature was a serious difficulty. This led to investigations with a view to obtain a homogenous metal, and it was easily comprehended, at this stage in the metal's history, that this condition required that such a metal should be produced by a process of fusion and pouring instead of by the method of welding theretofore practised. Several processes were devised with a view to obtain this much desired homogeneity: some proposed to decarbonize the molten pig iron by mixing with it as it poured from the furnace, powdered and highly oxidized ore, to operate in reducing the portion of carbon to such a small degree that its presence would not be objectionable, a proportion of one quarter of one per cent. having been found to be no serious objection unless the iron is required for smithing or welding purposes.

At this stage it was proposed by Mr. Bessemer to put the melten metal into a suitable vessel and blow air under pressure through the mass in order to burn up the carbon by admixture with oxygen; other processes were made passible by the discovery by Mr. afterwards Sir Wm. Siemens, of a means of obtaining much more intense heat in furnaces by using the waste heat of a present conduct of operations to heat up a nest of refractory brickwork, through which in turn the

air for a continuation of the processes of the furnace is in succession drawn. The intense heat thus obtainable would have rendered possible the fusion of even the malleable iron, but in the progress of experimenting it was found that with this furnace a charge of metal could be kept in a state of fusion while tests of the constitution of its charge were being made, and the correct or desired result having been thus reached, the whole charge could then be drawn off into ingots to be shaped into the desired shapes as required. This, with the further improvements in the method of Bessemer, principally the invention of Mr. Mushet, whereby the charge was suitably mixed with a certain kind of steely ore, very soon solved the problem of how to produce a homogenous iron, and the result is that today metal of the iron family can be obtained of every conceivable quality and capable of supplying the needs of the most exacting purposes.

The value of this feature of homogeneity is one which it is scarcely possible to over estimate, and, having arrived at this most satisfactory stage of the history of the iron manufacture, we are now enabled to solve problems in the application of the metal to various uses, and the production of articles from it in ways that up to a comparatively recent period, would have been simply impossible."

SIXTH ORDINARY MEETING, Church of England Institute, Halifax, 9th April, 1894.

The PRESIDENT *in the Chair.*

Inter alia,

A paper was read by Dr. D. A. Campbell, entitled : "General Considerations concerning Bacteria, with Notes on the Bacteriological Analysis of Water."

SEVENTH ORDINARY MEETING, Province Building, Halifax, 14th May, 1894.

The PRESIDENT *in the Chair.*

Inter alia,

The following papers were read :—

"Notice of a New Test for Antipyrine," by the President, Professor G. Lawson, LL. D.

"Phenological Observations made at several Stations in Nova Scotia and New Brunswick during the year 1893," compiled by A. H. McKay, LL. D., Halifax.

"Note on a Sponge from Herring Cove," by J. Somers, M. D.

"Notes on Nova Scotia Zoology, No. 3," by Harry Piers.

The following papers were read by title :—

"Notes on a Collection of Silurian Fossils from Cape George, Antigonish Co., N. S., with descriptions of three new species," by Henry M. Ami, D. Sc., F. G. S.

"Notes on Sedimentary Formations on the Bay of Fundy Coast," by R. W. Ells, LL. D., &c.

"Additions to the Flora of Truro," by Percy J. Smith.

"Deep Mining in Nova Scotia," by W. H. Prest.

A. McKAY, *Recording Secretary.*

Halifax, 19th May, 1894.

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Name of Member or Institution ....

Place ....

Date ....

LIST OF MEMBERS

ADMITTED TO THE INSTITUTE DURING THE SESSION, 1893-4.

(For full list see p. xii of Part 1, p. xlv of Part 2, and p. liv of Part 3).

ORDINARY MEMBERS.

	DATE OF ADMISSION.
Anderson, J., Surveyor, Halifax	Jan. 2, 1894.
Austen, J. H., Deputy Crown Lands Commissioner, Halifax	Jan. 2, 1894.
Fearon, J., Principal Deaf and Dumb Institution, Halifax	May 8, 1894.
Jacques, H. S., M. D., Halifax	May 8, 1894.
Marshall, G. R., Principal Richmond School, Halifax	April 4, 1894.
Spike, C. J., Halifax	May 8, 1894.
Tremaine, H. S., C. E., Architect, Halifax	Jan. 2, 1894.

CORRESPONDING MEMBERS.

Ami, H. M., D. Sc., F. G. S., Ottawa, Ont	Jan. 2, 1894.
Ells, R. W., LL. D., F. G. S. A., F. R. S. C., Ottawa, Ont	Jan. 2, 1994.

LIST OF INSTITUTIONS TO WHICH COPIES OF PART 3 OF VOL. I OF SERIES 2 OF THE PROCEEDINGS AND TRANSACTIONS HAVE BEEN SENT.

The Institutions mentioned on pp. xv-xxx of Part 1, xlv-xlvi of Part 2, and liv of Part 3, together with the following:

Boston, Mass.—The Society of Arts, Massachusetts Institute of Technology.
Berkeley, Cal.—The General Library of the University of California.
Chicago, Ill.—Western Society of Engineers.
Cardiff, G. B.—South Wales Institute of Engineers.
Cincinnati, O.—The Observatory, University of Cincinnatti.
Denver, Col.—International Mining and Industrial Exposition.
Geelong, Australia—The Museum, Gordon Technical College.
Hampton, Va.—The Hampton Agricultural Institute.
Helena, Montana.—Montana Society of Civil Engineers.
Kingston, Ont.—The Library, Queens University.
" " School of Mining and Agriculture.
Lyme Regis, G. B.—Rousdon Observatory.
London G. B.—Lord Lindsay's Observatory.
" " The Royal Botanic Society.
" " The Patent Office Library.

Moscow.—The Observatory.
Munich—Münchener Sternwarte.
Madras.—The Government Observatory.
Nice, France.—The Observatory.
Nijmegen, Netherlands.—Nederlandische Botanische Vereenigung.
New Brighton, Staten Id, N. Y.—Natural Science Association of Staten Island.
Oxford, G. B.—The Radcliffe Observatory.
Ottawa, Ont.—Director of Experimental Farms.
Paris, France.—Bibliothèque Nationale.
" —The Observatory.
Rio de Janeiro, Brazil.—The Imperial Observatory.
Santiago, Chili.—Sociedad Cientifica Alemana.
Toulouse, France.—Société Francaise de Botanique.
Toronto, Ont.—Astronomical and Physical Society.
Tufts College, Mass.—Tufts College Library.
Wolfville, N. S.—N. S. Fruit Growers' Association.

TRANSACTIONS

OF THE

Nova Scotian Institute of Science.

SESSION OF 1893-94.

I.—On the Measurement of the Resistance of Electrolytes.—By F. J. A. McKittrick, Physical Laboratory, Dalhousie College, Halifax.

(Read March 12th, 1894.)

During the present session at Dalhousie College, I wished to make a series of experiments, determining the electrical resistance of certain electrolytes. Not having the apparatus necessary for Kohlrausch's method at my disposal, I employed that used by Ewing and MacGregor (Trans. R. S. Edin., Vol. XXVII (1873) p. 51), which, according to the tests applied to it by Prof. MacGregor (Trans. R. S. Can., Vol. VIII (1890), Sec. III, p. 49), seemed capable of giving results sufficiently accurate for my purpose.

Since this method, for its most successful application, especially if used in the way suggested by Prof. MacGregor in the latter of these two papers, requires some training of the eye in observing the motions of a spot of light, I undertook a series of preliminary experiments. In the course of these experiments, certain improvements suggested themselves to me. These improvements and their effect on the working of the method, this paper attempts to point out.

As the above method has been fully described by Prof.

MacGregor in the paper already referred to, I need give but a short sketch of it here. The electrolytic conductor is introduced by Platinum electrodes as one of the arms of Wheatstone's Bridge, and the process of determining its resistance is the same as in the case of a metallic conductor, viz., by a gradual adjustment of the arms. The indications of the Galvanometer, however, will not be the same as in that case, owing to the fact that the electrodes become polarized through the passage of the current. The effect of this polarization on the Galvanometer is the same as if, during the passage of the current, the resistance of the electrolytic cell gradually increased.

Imagine the arms of the bridge so adjusted that, on the passage of the current, the light spot of the Galvanometer moves off to the right and remains there, such a deflection having been ascertained to mean that the resistance being measured, if metallic, was too small to give zero deflection. If we gradually change the adjustment of the arms in such a way as to diminish this deflection to the right, it will not be found possible to obtain an adjustment making the deflection zero, but an adjustment will be reached with which the light spot moves first to the right, stops, moves back and off to the left, showing that though at the beginning of the flow of the current, the resistance of the cell was small enough to give a deflection to the right, it has been virtually increased by the polarization until it is so large as to give a deflection to the left. We have thus a double deflection. As we continue changing the adjustment so as to diminish the initial deflection to the right, the double deflection will grow less and less until finally we shall have only the deflection to the left.

If we had a magnet and mirror of indefinitely small moment of inertia, hung by a fibre offering no resistance to torsion, so that it would, at any instant, indicate the direction of the current flowing through it, this double deflection would only just vanish when the adjustment of the arms indicated the exact resistance of the cell, *i. e.*, when the resistance of the cell, calculated in the ordinary way from the resistances in the other arms, would be its exact resistance.

With an actual mirror and magnet of finite moment of inertia, no appreciable motion can be observed till the current has acted for some time If the adjustment of the arms be such as to indicate a resistance for the cell only slightly greater than its real value, the first current flowing through the Galvanometer will be very weak, and, before it will have had time to produce an appreciable deflection of the mirror, the electrodes will have become polarized, and our only deflection will be one to the left If, then, we take the resistance of the cell to be that indicated when the double deflection has just vanished, we make an error, and conclude the resistance to be greater than it really is. Whether, with any magnet and mirror yet manufactured, this error can be made small enough to be neglected, can be determined only by experiment.

In their experiments, Ewing and MacGregor assumed that the light mirror and magnets of Lord Kelvin's Dead-Beat Galvanometer would give a close approximation to accurate results. In order to reduce polarization, they used as current generator only one Grove cell, and introduced large resistances into the arms of the bridge. Their determinations, however, when compared with those given by more elaborate and accurate methods, were found to be too large, differing from Kohlrausch's, in some cases, by as much as 12 per cent.

As their experiments were made when they were students and had acquired little experience in experimental work, the discrepancy may have been due to other causes than the defects of the method. Hence Prof. MacGregor, in order to test the method, made a series of experiments, described in the paper cited above, comparing the resistances of solutions of zinc sulphate as given by this method and by the use of non-polarizable electrodes. To reduce polarization, he also used weak currents and, in addition, electrodes of large area. He found that, if the mere vanishing of the double deflection were taken as the test of adjustment, the resistances determined would be too much greater than their real values to be regarded as a sufficiently close approximation. He noticed, however, that, when he could no longer observe a double deflection, he yet could notice a distinct hesitation at the

beginning of the single deflection. That this should be so is evident. For, after the double deflection has just vanished, the first current passing through the Galvanometer still tends to cause a deflection to the right, but is overpowered by the polarization current. Hence the mirror does not begin to move as soon as contact is made but, for a short time, remains at rest. Clearly then, if the adjustment of the arms be changed until we can observe not only no double deflection, but also no hesitation, we shall get more nearly accurate results. By observing the vanishing of the hesitation, Prof. MacGregor was able to get results which, in the case of high resistances, differed from their true values only by from 0.1 to 0.4 per cent.

I began, therefore, by endeavoring to observe the vanishing of this hesitation, testing my results in the same way as Prof. MacGregor had done in the paper cited above.

The electrolytic cell which I used consisted of strips of window glass cemented together with marine glue. Its length was about 16 cm., breadth, 8 cm., depth, 9 cm. It was divided transversely into two equal compartments by a glass partition cemented in so as to be water tight. Passing through the centre of this partition, and cemented at right angles to it, was a glass tube with its ends open. It length was 1 cm., the diameter of its bore 0.3 cm. At each end of the box I placed my platinum or amalgamated zinc electrodes, as the case might be. They were each about 7 cm. square and had narrow strips projecting above the box. To these strips of the zinc electrodes thick copper wires had been soldered without the use of acid; to the platinum electrodes, thick platinum wires had been welded. By these wires the cell could be joined up as an arm of the bridge.

The electrodes were, in all cases, placed as close as possible to the ends of the box. Since, however, the resistance of the column of liquid in the tube was about 1,000 times that of a cross section, 1cm. in length of the liquid in the box, slight differences in placing the electrodes made no appreciable difference in the resistance of the box.

The part of the box above the surface of the liquid (especially that of the glass partition) was kept clean and dry, and, during

the experiments, except where the narrow strips of the electrodes projected upwards, the box was kept covered.

With this cell (1) it was the same liquid, whose resistance was measured whether the platinum or zinc electrodes were used, and (2) the tube being in the centre of a large mass of liquid, that liquid being approximately at the temperature of the laboratory, and the time intervening between two measurements, one by platinum the other by zinc electrodes, being small, any change in the resistance due to change in temperature might be neglected.

The box of resistance coils used was a small one. The coils were arranged so as to form three arms of a Wheatstone's Bridge. Two of them contained two coils each, 10 and 100 Siemens units respectively. The third contained a number of coils ranging from 500 to 1 Siemens units, together with a rheochord for measuring fractions of a unit. The coils had been accurately calibrated in Legal Ohms by White, of Glasgow.

The Galvanometer used was a "dead beat" one of Lord Kelvin's, having a resistance of 400 ohms. The mirror, with magnets attached, weighed 0.035 grms.

For making and breaking contact I used a "rocker," like that described by Ewing and MacGregor in the paper referred to above. It was so designed that the battery wire was joined up a small fraction of a second before that of the Galvanometer.

I found that I was unable with any certainty to detect the vanishing of the hesitation. To my eye it did not seem to vanish even when the adjustment of the arms indicated less than the actual resistance of the cell. The motions of the magnet certainly became quicker then, but none the less did I think I could detect a hesitation. Nor is this other than we would expect. The current must always act for a certain time before any appreciable motion of the mirror occurs. The length of this time will vary with the strength of the current. With a weak current the magnet always starts slowly, while with a strong current it may seem to start almost instantaneously. With a certain current and a certain resistance of our cell, there will be a particular hesitation corresponding to the adjust-

ment of the arms indicating the exact resistance of the cell. With considerable practice we may train the eye to recognize this particular hesitation, so that, within a short range of this resistance of the cell, we may be able to make almost perfect measurements. This was the only way in which I was able to use Prof. MacGregor's method and the result was unsatisfactory. For when the resistance of the cell was changed to any extent, the strength of the current changed and I found that my familiar hesitation was no longer that which corresponded to the adjustment of the arms indicating the resistance of the cell.

In my experiments I noticed, however, what is clearly evident, that, the stronger the currents, the greater was my double deflection, that if, for certain resistances of the arms, with a certain current I could get a double deflection, then with a stronger current I would get a larger deflection, and, what to me was more important, if, in the former case, the double deflection had just vanished, in the latter case it was distinctly visible. I immediately tried still stronger currents and found that in every case the stronger the current the nearer would the adjustment of the arms, when the double deflection had just vanished, indicate the true resistance of the cell. It appeared, therefore, that I had merely to increase the strength of the current to make my error as small as I pleased.

In attempting this, however, difficulties arose:

(1.) As the battery current was increased, so was the polarization current. To lessen this my electrodes were made as large as possible. As I have stated above, they were about 7 cm. square. I might have platinized them, after the manner of Kohlrausch; but as the method under consideration, owing to the simplicity of apparatus required, is especially useful for measuring resistances of electrolytes in ordinary laboratory work, I was more interested in knowing what degree of accuracy was attainable by it with apparatus which is always at hand.

(2.) Since the motions of the mirror are indicated by those of the spot of light reflected from it to a screen, in proportion as the double deflection gets smaller and smaller, the difficulty in observing it gets greater and greater. Especially is this so if the

current be strong, for then the motions of the spot become so rapid that, unless the double deflection is distinctly made, we are not able to observe it. This difficulty I completely removed by placing a rectangular sheet of zinc three or four inches in front of, and hiding from my eye, the left side of the screen. It was easy to place this so that, on looking past its right edge, I could just see the faintest glimmer of the spot of light. Since I always sent the current in such a direction that the double deflection was to the right, it is evident that even the least tremble of the spot to the right could be at once observed. More especially was this so, as the sheet of zinc was much nearer to the spot of light than to my eye. It is necessary, of course, that the edge of the spot of light that we are observing should be very clearly defined, and that no motion of the head should be made at the instant of observation.

(3.) With strong currents electrolysis of the solution goes on at a rapid rate, and, again, there is danger of the coils becoming heated. During the final measurements, then, when we are using the strongest currents, contact in the battery wire must last only for a small fraction of a second. The "rocker," thus, became too slow a means of making and breaking contact. By joining up the Galvanometer first and by a separate key (a method to be justified later) the solution of this difficulty became easy, for then we have only to make and break contact rapidly in the one wire. This I accomplished by slightly flattening a piece of thick copper wire, and sinking it into a board till its flattened surface was only slightly above that of the board. This wire I connected with one of the battery wires. The end of the other battery wire I flattened, and by simply drawing it over the board and across the wire, contact could be made and broken as rapidly as desired.

I found it quite impossible, as did Ewing and MacGregor, and Professor MacGregor, to obtain platinum electrodes which, in themselves, did not constitute a voltaic cell. In every case my electrolytic cell was found to be a voltaic cell with a small and, apart from polarization, practically constant E. M. F. It is evident that, with this method, the adjustment of the arms which would give no double deflection, would not be exactly the same

as if the electrolytic cell were not behaving as a voltaic cell.

Both Ewing and MacGregor, and Prof. MacGregor overcame this difficulty in this way. Call e the E. M. F. of the cell. Pass a current through the cell in such a direction as to produce a polarization current greater than, and opposite in direction to, that produced by e. Then, as this polarization slowly dies away, there will be a short time during which it will neutralize e. During that time they considered that the test could be made without error due to e.

To this procedure there are objections. In order to produce the necessary polarization so that it will die away slowly, the current must pass for a certain time, and thus a certain amount of electrolysis goes on—the more, the stronger the current. Then there is the great difficulty in making the test at the instant at which e is exactly neutralized. In my very many trials, I am not certain that I succeeded in making one test with which I was perfectly satisfied. In any case we do not entirely eliminate error due to e. For we have neutralized e only by covering our electrodes with gas, which must make the resistance of our cell appear greater than it really is. Since, however, e can always be made very small, this error is, in practice, negligible.

In his paper, Prof. MacGregor pointed out one result of which he made no use, but which suggested to me an easier solution of this difficulty. What he showed was, in effect, that if the Galvanometer wire be joined up first and the spot of light be allowed to take up a new position due to e, and if the adjustment of the arms corresponds to the exact resistance of the cell, then, on making contact in the battery wire, the current through the Galvanometer due to e will remain unaltered. It seems reasonable to suppose therefore that, if the adjustment of the arms nearly corresponds to the exact resistance of the cell, and if e be very small, then, under these circumstances, any change in the current due to e flowing through the Galvanometer, which occurs when contact is made in the battery wire, will be very small. If then we should join up the Galvanometer wire first and make our

measurements as if e had the value zero, would the error be negligible?

To test this, I simply made several measurements, first by this method, and then by neutralizing e. I varied both the size and the direction of e, but, in no case, was I able to notice any difference in the two measurements.

To proceed in this way, however, the Galvanometer must be joined up first. Rigorously this will not give accurate results; for the principle on which measurement of resistances by Wheatstone's Bridge rests, requires that the current shall have attained a steady value. Whether, practically, with circuits such I was using, any error would be introduced by this method, could be decided only by experiment. To test this, I simply measured the resistance of a solution of zinc sulphate, using amalgamated zinc electrodes, first joining up the battery wire before the Galvanometer wire, and then *vice versa*. The experiments that I made perfectly satisfied me, that the error, if there was one at all, was clearly negligible.

During my experiments the resistance of my cell varied from 100 to 10,000 Legal Ohms. The accuracy with which I could determine the resistance is shown in the following table, which gives a few average results:—

No. of Grove's Cells used.	Resistance as determined by		Error.
	Amal. Zn. Electrodes.	Pt. Electrodes.	
1.	6360 Legal Ohms.	6430 Legal Ohms.	1.1 %
2.	6360 "	6420 "	.94 %
3.	6360 "	6407 "	.74 %
8. of low internal resistance.	177.3 Legal Ohms.	178.2 Legal Ohms.	.51 %
	634.9 "	637.8 "	.46 %
	1893 "	1900 "	.37 %
"	4585 "	4595 "	.22 %
"	7439 "	7450 "	.15 %
"	9139 "	9151 "	.13 %

As stated above, Professor MacGregor's error in the measurements of high resistances varied from 0.1 to 0.4 per cent. With low resistances, however, his error was as great as 6 or 7 per cent. The first three entries of the above table show, then, that, with a comparatively weak battery as current generator, the errors in the resistances determined by employing the vanishing of the double deflection as test of adjustment, are comparatively large, considerably larger than they would be according to Professor MacGregor's experience, if the vanishing of the hesitation were taken as the test. The last seven show that, with a strong current, the employment of the vanishing of the double deflection as test of adjustment gives results which, in the case of high resistances, are considerably more accurate, and in the case of low resistances very much more accurate than those given by a weak battery with the vanishing of the hesitation as test.

It would thus appear that the above modifications render this method capable of measuring all resistances with increased accuracy and low resistances with greatly increased accuracy, while they render it also capable of application without any previous training of the eye, and diminish very materially the time required for its application. The error in the measurement of high resistances is still greater than that of Kohlrausch's method, viz., 0.05 per cent. The only mirror, however, which was available for my experiments, though it weighed but 0.035 grms, was much heavier than some which I believe are now manufactured. With a lighter mirror the inevitable error would doubtless be still further diminished.

II.—NOTE ON VENUS,—MORNING STAR AND EVENING STAR AT THE SAME TIME, FEBRUARY, 1894.—BY A. CAMERON, PRINCIPAL OF THE ACADEMY, YARMOUTH, N. S.

(Read 12th March, 1894.)

On Tuesday, February 13th, 1894, I saw Venus as an evening star in the west after sunset, and next morning I saw her in the east before sunrise. I don't know whether such a pair of observations has been made before, and think it may be as well to put them on record.

On both occasions the planet was first found with a field-glass but after being found she was seen quite distinctly with the naked eye. The eye-observation was much easier in the evening than in the morning, because on the former occasion Venus was in a bit of clear sky, while on the latter the sky was streaked with lines of thin cloud. Apart from sky conditions, however, her brilliancy was less on the morning of the 14th because she was nearer inferior conjunction then. Had there been no glass at hand, the eye could easily have found her on the evening of the 13th, but I don't think it could have done so at all—certainly it could not have done it easily—in the gray-and-yellow-streaked sky of next morning.

As the observations were made very near inferior conjunction, the planet's phase was very small, only about one-hundredth of the disc being illuminated. The field-glass used has a magnifying power of four diameters, and in it the thin crescent was well defined and looked very pretty.

* * * * *

It is as *a pair* that these observations appear to me to be specially worth noting. To see Venus in the evening *after sunset* and to see her again *next morning before sunrise* (the seeing being done with the naked eye or with a low-power field-glass) is a kind of double observation which can not often be made and

which I am inclined to think has not often been made. If any reader of this note knows of another instance of the same kind he will confer a great favor by sending me a report of it.

But even singly they are not altogether without interest, and especially when considered in connection with the papers on eye and opera-glass observations of Venus published in the Transactions of this Institute for 1891-2 and 1892-3.

The time of inferior conjunction this year was February 16th, 5 a. m. (60° W. time). The time of the evening observation on February 13th was 6 p. m. Here then we have an eye-observation of Venus after sunset within two and a half days of inferior conjunction. There is no observation of this kind in either of the papers mentioned which is as good as this one. In point of time it is closer than any previous observation I know of near conjunction, but in point of distance it is not as close as one or two of the best daylight ones recorded in the 1892-3 paper. As a field-glass-observation, of course it can't compare at all with the one made at the very time of conjunction on the afternoon of July 9th, 1892.

The morning observation with the eye supersedes the evening one as the nearest in point of time to conjunction, the interval being less than two days. That is really the chief feature of this observation, but apparently there is another which, if not more important, is much more curious. It is at inferior conjunction that Venus ceases to be "evening star" and begins to be "morning star," according to the technical language of the almanacs. So, this year, Venus did not begin her career as "morning star" until 5 a. m. on February 16th. But she was seen above the eastern horizon before sunrise on the morning of February 14th. That is, she was seen as a genuine morning star —*the* morning star, indeed, for she was the last of all the stars that morning to faint and die out in the light of the rising sun —two days before she began to be a technical "morning star."

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It seems hardly worth while to tell how such an apparently curious observation came to be made, but this note may fall under the eyes of some who would like most of all to know that very

thing, and it may therefore be not amiss to say a few words about it.

The opportunity for seeing Venus as morning star while she is still both really and technically an evening star can only occur near inferior conjunction. And only then,—to observers in the northern hemisphere,—when her declination is considerably north of the sun's.

Near conjunction, Venus and the sun pass the meridian at nearly the same hour, and of course, this hour is for each of them half-way between the hours of rising and setting. When Venus is north of the sun she is above our horizon for a longer time than he is, and the extra time is divided equally between the two halves of her daily course, the one before meridian passage and the one after. If these two sentences are fully understood, it will be obvious that when the two conditions occur together Venus will both rise earlier and set later than the sun.

She did so this year, in the latitude of Yarmouth, on the twelve days following February 6th. During the first three or four of these days the interval between her rising and sunrise was too short to let one get a sight of her, and the same is true of the interval between sunset and her setting on the last three or four days. And the weather was bad then too; in fact, it was bad observing weather during the whole twelve days, except only from about sunset on the 13th until the forenoon of the 14th. Luckily this just covered the time when the astronomical conditions were most favorable for both the evening and the morning observations. On the evening of the 13th, Venus stayed with us forty minutes after sunset, and she was up next morning nearly as long before sunrise.

It has already been mentioned that the evening observation was easy. It was also unpremeditated and unprepared for. The weather had been so bad for so long that the observing habit had slipped off. An accidental look out—a gap seen in the clouds near where Venus should be—a few seconds' search, first with glass and then with eye, that was all. But such happy-go-lucky methods could not be trusted to for the morning observation. It was long since an observation of any kind had been

made in the morning; it was far longer since one had been made on Venus; and my eastern horizon was less favorable for low observations and much less familiar to the observer than the western. But the night of the 13th looked as if it would keep clear until dawn, and it seemed a shame that the promising opportunity should be lost. If only some star could be found with nearly the same declination as Venus, which would rise about 10 or 11 that night, and let itself be seen above the tree-tops in the east, the morning observation would be assured. Such a star was found, and when its position had been observed a note was jotted down that, at a certain hour next morning, looking from a certain window, Venus should be seen at the top of a certain tree. When the hour came I was at the window and Venus was at the top of the tree.

III.—Notes on Nova Scotian Zoology: No. 3.—By Harry Piers, *Assoc. Member A. O. U., Halifax, N. S.*

(Read May 14th, 1894.)

Two series of these notes have already appeared in the Transactions of the Institute of Science. The present contribution, owing to the scarcity of unusual occurrences relating to other divisions of our zoology, is almost entirely confined to records of new or rare birds recently observed in the province. More than ten species are thus noted which were not mentioned in the late Mr. Andrew Downs's catalogue*, a few of which are also new to the ornithological fauna of the Dominion of Canada. Of course, most of these are stragglers from their regular habitats.

I have not been able to chronicle any item of great importance regarding the mammals of the province. As a consequence of their non-migratory habits, they are in one way less likely to present novel incidents for record than a class, such as the birds, which is composed of animals able to go at will from one region or country to another. On the other hand, the study of the habits of the former will still repay any labour devoted to it, for owing to their being thus confined as individuals to a limited range, they are more liable to the development of local characteristics than most of the latter animals, which are wanderers of cosmopolitan tendencies

During the summer of 1892, I was at King's College, Windsor, Hants County, and thus had an opportunity of studying the natural history of that district, and the relative abundance of various species in the eastern and western parts of the province. One or two observations upon the subject have been inserted in the present paper. The faunal differences, however, did not appear to be as great as those relating to the flora of the two districts.

* "Catalogue of the Birds of Nova Scotia." *Trans. N. S. Inst. of Nat. Sc.*, vol. VII, pp. 142-178.

I wish to thank Messrs. Purcell and Egan, taxidermists of Halifax, for information regarding birds they have mounted, and for the liberty they have given me of inspecting their collections. To others, also, especially Mr. James McKinlay, of Pictou, N. S., I am much indebted for particulars relative to rare specimens.

MAMMALS.

BLACK RAT *(Mus rattus).* One of these animals was killed by a cat in Mr. S. Dawson's country house, Pictou, in October, 1887. It is now preserved in the museum of the Academy. The species is very rare in Nova Scotia, and Dr. J. Bernard Gilpin, at the time he prepared his papers on the mammalia of the province*, knew of only four instances of its occurrence. One specimen was mounted by Mr. A. Downs, two others were procured by himself, and the fourth was given to him by Mr. J. R. Willis. It has also been observed on the Pacific sea-board, but nowhere has it penetrated far into the interior.

BIRDS.

HOLBŒLL'S GREBE *(Colymbus holbœlii).* A male was shot near Halifax, on 9th April, 1891. Another in full breeding-plumage was killed on 25th April, 1894. Both were mounted by Mr. Thomas J. Egan, of Halifax. In the spring, about five years ago, the same gentleman obtained a specimen of the immature bird—the only one he has ever noted. At this age, the species for many years was erroneously described by naturalists as the "Crested Grebe," owing to its resemblance to the British bird of that name.

HORNED GREBE *(Colymbus auritus).* Mr. Downs only knew of one instance of this bird having been taken in Nova Scotia. It may be as well to record that the specimen which he referred to, was one which had been set-up many years ago by Mr. Egan. Since then, the latter taxidermist purchased two, male and female, in full spring plumage, which were shot together at Lawrencetown, Halifax County, on 17th or 18th April, 1894. They were brought to Halifax on 21st April. Another, a male,

* *Trans. N. S. Inst. Nat. Sc.*, vol. II., pt. iv., p. 12.

was killed at the same place on 20th April, 1894. It is a rare bird in Nova Scotia, although, strange to say, Mr. Chamberlain *(Catalogue of Canadian Birds)* speaks of it as common throughout the Dominion, and breeding from about latitude 45 degrees northward.

IVORY GULL *(Gavia alba).* Mr. Egan has two specimens of this gull. The first was taken on 15th October, 1889, in the island of Cape Breton. The second, a male, was obtained at Chezzetcook, to the north-east of Halifax, on 26th October, 1892. This is an Arctic species which in winter comes south as far as Labrador and Newfoundland. Its occurrence in Nova Scotia, therefore, is probably merely accidental. Chamberlain *(Catalogue of Canadian Birds)* says that a few examples have straggled to the Bay of Fundy and to Lake Ontario. The species is noted as "rare" in the late Mr. Downs's Catalogue. Mr. J. M. Jones in his paper "On the Laridæ of the Nova Scotian Coast,"* says that only one specimen, as far as he was aware, had been observed on our coast. It had been seen by Capt. Wedderburn, 42nd Royal Highlanders, in Halifax Harbour some years before the time of writing.

RING-BILLED GULL *(Larus delawarensis).* In the *Ornithologist and Oologist* for August, 1890, page 122, Mr. F. A. Bates in his "Wanderings, No. 8," says, that while at Three-fathom Harbour, Halifax County, with Mr. Egan, a shot fired at a gull brought it wounded to the flats, where its cries attracted a large flock, two of which were killed.† These two, he states, "subsequently proved to be probably Ring-bills (A. O. U. No. 54) in young plumage." "I am informed by friends in Halifax," he goes on to say, "that this is a somewhat unusual occurrence, and Mr. Downs, the veteran ornithologist of Nova Scotia, never saw it, and does not mention it in his list. This seems rather strange, as the bird is common on all sides of the Province. Mr. Harry Austen, of Halifax, who possesses one of the birds, writes me that the nearest point at which he knows of the bird is on the Canadian Lakes, and until further noted we must only

* *Trans. N. S. Inst. Nat. Sc.*, vol. II, pt. iv, 1870.

† This was during the latter part of September, 1889.

accept it as a probable addition to the list of the birds of Nova Scotia." Although Mr Downs had not personally observed the bird, and therefore did not include it in his catalogue, yet Mr. J. M. Jones mentioned it in his paper "On the Laridæ of Nova Scotia," before quoted, appending thereto the following equivocal note: "Although known on our coast, of the habits or distribution of this species we possess but meagre information. I am inclined to think that this is the species which I have observed keeping company with the steamer the whole way across the Atlantic." Mr. Ridgway in his *Manual of North American Birds* (p. 32) says that the species is found over the whole of North America, breeding far northward, and migrating south, in winter, to Cuba and Mexico. I think that there is no doubt that it occurs on the coast of Nova Scotia, but for some reason it has escaped the guns of our naturalists Mr. Egan thinks that Mr. Bates's specimen was correctly identified.

LAUGHING GULL *(Larus atricilla)*. Three specimens, all of which came from Devil's Island, at the entrance of Halifax Harbour, are in Mr. Egan's collection. Two of these were killed on 10th September, 1888. The third, a female, was obtained on 15th June, 1892. There is also a fourth specimen in the McCulloch collection, belonging to Dalhousie College, Halifax. This species was not included in the "Catalogue of the Birds of Nova Scotia." Its occurrence, however, was to be expected in the province, for Mr. Chamberlain had mentioned it as having occasionally been found in the Bay of Fundy.

CASPIAN TERN *(Sterna tschegrava)*. In May, about eight years ago, Mr. F. Bell, of Dartmouth, obtained a specimen of this very rare bird, which had been killed at Cole Harbour, Halifax County. It now belongs to Mr. Egan, who also has another which was shot last year (1893). The late Mr. Downs, I understand, got one from Cole Harbour shortly after Mr. Bell's specimen was taken. The same man killed both.

BLACK TERN *(Hydrochelidon nigra surinamensis)*. Mr. Egan informs me that he has two specimens, in immature plumage, which were killed at Devil's Island, Halifax Harbour, on 10th September, 1888. It is the only record for the province.

Brown Pelican *(Pelecanus fuscus).* On 31st May, 1885, a Brown Pelican was seen to alight on a salt-water marsh at River John, Pictou, N. S., where it was approached without much difficulty and killed. Upon examination the body was found to be emaciated and the pouch entirely empty. The skin was mounted, and is now in the museum of Pictou Academy. It is in full nuptual plumage, and has a greenish black pouch. The latter was at first slightly shaded with green and blue, but it soon afterwards turned to its present colour. Mr. James McKinlay writes me that on 1st June, 1893, an adult male of the same species was shot on Pictou Island by Mr. J. Hogg, the lighthouse keeper. It was slightly larger than the first specimen, from which it did not differ materially either in form or colour. From tip of bill to end of tail, it measured 4 feet 7 inches; bill, 12½ inches; tarsus, 3¼ inches. No food whatever was found in the stomach, and its flesh was in poor condition. It probably will be also placed in the Academy museum. On 19th August, 1889, my brothers, while on the shore of Bedford Basin, saw a bird which was probably a Pelican. They described its general colour as grayish, and it had a pouch beneath the bill. When observed, it was flying from the north-east to the south-west. The species must only be regarded as an accidental visitor. It is not mentioned at all in Mr. Chamberlain's *Catalogue of Canadian Birds*, the most recent general work upon the subject. Its habitat is the coasts and islands of the Gulf of Mexico and Caribbean Sea, including the West Indies; north, regularly, to North Carolina, accidentally (blown by storm?) to Illinois (Ridgway). I may as well mention that Mr. Chamberlain, speaking of another species, the American White Pelican (*P. erythrorhynchos*), says that "one specimen has been taken in Nova Scotia and two in New Brunswick." I know nothing of the Nova Scotian specimen referred to.

Redhead *(Aythya americana).* This is a rare migrant in Nova Scotia, but it is common from Montreal to Western Manitoba, and Mr. McIlwraith *(Birds of Ontario)* reports it as one of the most abundant species which visit Lake Ontario. Mr. Harry

Austen, of Dartmouth, obtained a Nova Scotian specimen about the beginning of February, 1894.

KING EIDER *(Somateria spectabilis).* On 4th April, 1894, a King Eider was brought to Halifax, which had been shot at Sambro, Halifax County, about 21st March. Another was brought from Lawrencetown, to the north-east of Halifax, on 7th April, 1894. It was quite fresh and had evidently been killed two or three days before. Both were mounted by Mr. Egan. Mr. F. Bell also has a specimen.

GREATER SNOW GOOSE *(Chen hyperborea nivalis).* According to Mr. James McKinlay, this species is seen at intervals in Pictou County early in the season, either in small numbers or else singly in company with the Canada Goose. An instance occurred in April, 1894, at Caribou Harbour, at which place geese are wont to congregate in large flocks during the vernal and autumnal migrations. It did not fly with the Canada Geese; and when it attempted to join them, it was driven back. Mr. McKinlay tells me that half a century ago the species was less uncommon in the county just mentioned, and on two occasions a small flock of five or six was observed. It was impossible, however, to approach within shooting distance of the birds, owing to their extreme wariness. They were rarely seen to alight, and only then on some long, bare sand beech or exposed salt-water marsh. Their colour apparently was pure white. Unfortunately none have yet been shot. Mr. Downs recorded several specimens in his catalogue, and there is also one, I understand, in the McCulloch collection, Dalhousie College Museum.

BRANT *(Branta bernicla).* A curious freak of nature is seen in a female Brant which Mr. Egan purchased on 9th April, 1894. It came from Amherst, N. S. In ordinary individuals the head, neck, body anteriorly, quills, and tail are black, and the back brownish-gray. The neck of the present one is not of the normal colour, but white; the head, bill, sides of breast, back. wings, tail, and legs, only being blackish. The dark colour of the head extends posteriorly as far as the occiput, whereas anteriorly it extends to the lowest part of the throat, or perhaps somewhat beyond. The eyes were of the ordinary colour. Mr.

McKinlay has since written to me that in April, 1894, a "white Brant" had been seen with a number of others of the normal colour. He had not heard of the specimen just noted.

GLOSSY IBIS *(Pleyadis autumnalis).* Mr. J. McKinlay reports that early in May, about twenty-seven years ago, while the weather still was cold, a farmer who lived near the head waters of the East River of Pictou, noticed two odd-looking birds on the margin of a grassy lake. With some difficulty he managed to get within gun-range, and fired, killing one and putting its companion to flight. They proved to belong to the above species, and had evidently wandered far from their southern habitat. Mr. Downs had one specimen of this bird, taken in our province, and Mr. Thomas Brewer informed him that a flock passed through the New England States about the same time. This is the flock referred to in the "Catalogue of the Birds of Nova Scotia." In 1878, Mr. Frank L. Tileston saw several birds "undoubtedly of this species" in Prince Edward Island,* and Mr Francis Bain speaks of it as an "occasional visitant" in that province.† The latter expression, however, does not sufficiently indicate its rareness. for it is merely an accidental straggler in the Dominion of Canada.

CLAPPER RAIL *(Rallus longirostris crepitans).* On 12th May, 1892, one of these birds was brought to Mr. W. A. Purcell, taxidermist of Halifax. It had been killed at Lawrencetown, Halifax County, probaby a day or two before. In October, 1893, Mr. Egan also obtained a specimen which came from the same locality. These are the only ones they have ever noted in the province. The species is not included in Mr. Chamberlain's catalogue, nor can I find any other record of its occurrence in the Dominion. It is a regular visitor as far north as Long Island, and has been observed occasionally in Massachusetts. But one example, apparently, has been reported north of Boston; it was taken near Portland, Maine.‡

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* Chamberlain, *Catalogue of Canadian Birds*, p. 31.
† *Birds of Prince Edward Island*, 1891, p. 69.
‡ Chamberlain's *Ornithology of U. S. and Canada, based on Nuttall's Manual*, 1891, p. 187.

RED PHALAROPE *(Crymophilus fulicarus.)* About May, 1893, Mr. Egan received nearly twenty specimens, all brought to him at the same time. I have only seen one in Mr. Downs's collection. The species is said to be common on Sable Island.

NORTHERN PHALAROPE *(Phalaropus lobatus).* Mr. Egan also had about a dozen of this species brought to him at the same time at which he received the Red Phalaropes mentioned in the preceding note. He does not consider the northern species as rare as did Mr. Downs, who mentioned it as "occasional, spring and fall."

RUFF *(Pavoncella pugnax)*?. On the 27th May, 1892, a male bird, probably in immature plumage, was shot at Cole Harbour, Halifax County. Mr. Egan, who mounted the specimen, was unable to determine the species to which it belonged, and therefore sent it to Mr. George A. Boardman, with a request that it should, if possible, be identified. Mr. Boardman, after examining it, forwarded it to the Smithsonian Institution at Washington. The latter merely replied that it was a young male Ruff. Since then, Mr. Egan, who was unsatisfied with this identification, took the bird to the United States, where it was carefully examined by Mr. William Brewster, Mr. F. B. Webster, and a number of other naturalists, all of whom agreed that the specimen differed in some points from the European Ruff. This had also been Mr. Boardman's opinion, but he subsequently waived it to a slight extent, under the impression that the Smithsonian Institution must be correct in its determination. Many series of skins of the Ruff were examined, but no specimen agreed altogether with the example from Nova Scotia. I think the bird may prove to be a hybrid. When killed, its legs were *black*. The "ruff" is wanting. The following measurements were made by me from the mounted bird: length of wing, 6.60 ins.; middle tail-feather, 2.30; gape, 1.42; depth of bill at base .25; tarsus, 1.70; middle toe, with claw, 1.37. Considering the uncertainty connected with the identification of the specimen, its name is inserted here with a query. If it proves to be a Ruff, it is of course a straggler from the Eastern Hemis-

phere. One or two have been killed on the Bay of Fundy, but it has more frequently been taken on the New England coast.

CANADA GROUSE *(Dendragapus canadensis)* and CANADIAN RUFFED GROUSE *(Bonassa umbellus togata)*. A hybrid between the "Spruce" and "Birch Partridges," shot about three or four years ago, is said to be in the collection of Mr. S. Dawson of Pictou. Mr. McKinlay says he has only observed one other such specimen from that neighbourhood. I have seen one in Mr. Downs's possession He bought it at a butcher's shop in Halifax.

MOURNING DOVE *(Zenaidura macroura)*. This species is not quite so scarce as formerly, and a few are usually shot each autumn. Mr. McKinlay considers it more rare about Pictou, and has noted only two specimens which were obtained near that place about nine years ago. One was shot in a garden where it was picking up such food as the spot afforded, and the other was killed a few miles from the town of Pictou, about the end of October, while associating with the barn-yard fowls—pressing want having rendered it fearless. A specimen was shot at the Eastern Passage, near Halifax, on 28th October, 1891, and was set-up by Mr. Purcell. On the 8th October, 1892, my brothers, Messrs. Charles and Sidney Piers, observed a bird on the St. Margaret's Bay Road, near the Chain of Lakes, which without doubt was either this species or else a Passenger Pigeon.

GRAY GYRFALCON *(Falco rusticolus)*. An individual was killed at Porter's Lake, Halifax County, on 15th October, 1887. It was mounted by Mr. Egan, who says it is the only one he has ever seen. Mr. George A. Boardman, I understand, has two from the Bay of Fundy. The species is not in Mr. Downs's list. The four forms of the Gyrfalcon—the White, Gray, Black, and *F. rusticolus gyrfalco*—were separated by the American Ornithologists' Union. Very recent researches seem to show that this classification will ultimately have to be abandoned, and but one species recognized, with two or three geographical races.

DUCK HAWK *(Falco peregrinus anatum)*. About the middle of September, 1892, two of these powerful and beautiful birds were shot on McNab's Island, Halifax Harbour, one being killed

a day or two before the other. The plumage of the first was somewhat darker than that of the second, and the head seemed to be slightly broader. The general colour markings, however, were the same in each. One was doubtless a young bird, which is more deeply ochraceous than an adult. Both specimens were prepared by Mr. Purcell for two soldiers who were then in the garrison. The species—which is merely a geographical race of the Peregrine Falcon of Europe and parts of Asia—is very rare in Nova Scotia. Mr. Downs had obtained one specimen from the Halifax market. I know of no others which have been taken.

SAW-WHET OWL *(Nyctala acadia).* The abundance of this species in February, 1892, has been recorded in a former contribution. During the winter of 1893-4, however, it was again uncommon; Mr. Purcell only having had four specimens. Three of these were taken since 11th January, 1894. One was found dead on Coburg Road, Halifax.

SCREECH OWL *(Megascops asio).* This is a new bird to our fauna, no instance of its capture having previously been recorded. About the last week of September, 1892, Mr. Purcell stuffed a specimen which had been killed by "Josh" Umlah, who lives on the Prospect Road, near Indian Lake, to the south-west of Halifax. It presented the red phase of plumage. The mounted bird now belongs to Mr. George Beamish of this city.

AMERICAN HAWK OWL *(Surnia ulula caparoch).* On 13th December, 1893, one of these very rare Nova Scotian owls was brought to Mr. Purcell. It came from Annapolis, and was quite fresh—probably having been killed a few days previously. Mr. Downs got one early in 1889. Mr. Austen has two.

PILEATED WOODPECKER *(Ceophlœus pileatus).* This handsome bird, the Great Northern Chief as it is sometimes called, will probably at length succumb to the advances of civilization. It is an uncommon or rare resident in the province, and is only found in heavily wooded districts. There is no record of its breeding near Halifax, nor have I ever heard of it even having been observed in that locality. A specimen was shown to me by Mr.

Purcell on 4th February, 1892. It had been shot about a week before, in the vicinity of Upper Rawdon, Hants County.

RED-HEADED WOODPECKER *(Melanerpes erythrocephalus).* I find in Mr. Egan's collection one specimen in full plumage, which he informs me is the only one he has ever seen during the time he has practiced taxidermy in this city. It was shot at Ketch Harbour, about ten years ago, and is to be considered as a mere accidental visitor. Mr. Downs only mentioned it as such. Strange to say, it is a common summer resident, and probably the best known of the woodpeckers, from Ontario westward to the Rocky Mountains.

CHUCK-WILL'S-WIDOW *(Antrostomus carolinensis).* Mr. McKinlay writes me that three years ago, toward the end of October, a countryman of Pictou picked up near his barn-yard a specimen of the Caprimulgidæ, which was so weakened by cold and hunger that it expired almost immediately after being taken in the hand. It was mounted by Mr. S. Dawson, and is now in the museum of Pictou Academy. My informant and Mr. W. A. Hickman, who recently examined the bird at my request, state most positively that it has *lateral filaments on the bristles on the side of the upper mandible.* This is a characteristic of the Chuck-will's-widow, and distinguishes it from all its congeners. It was carefully compared with Audubon's description, with which it agrees. There is a yellowish streak upon the throat, but not a white patch as is sometimes the case. The outer tail-feathers are devoid of white, showing that the specimen is a female. The wings are barred with yellowish red, and minutely sprinkled with brownish black. The exact length could not be ascertained with certainty, but is probably about eleven or twelve inches. Mr. McKinlay says "it may in all sincerity be pronounced a bona-fide Chuck-will's-widow." It was reported, he says, that the cries of the species had been heard at certain times, but such, he continues, has not been properly substantiated. At first I was very doubtful about inserting the species in my notes, for it seemed more probable that the specimen was a Whippoorwill, whose upper parts are somewhat similar in colour; later information, however,—especially

that regarding the filaments on the rictal bristles—has completely reassured me. The Whippoorwill has previously been found in Nova Scotia, whereas the Chuck-will's-widow only ranges north to North Carolina and Southern Illinois, and has not hitherto been detected in Canada. The present specimen can only be regarded as a mere straggler.

NIGHTHAWK *(Chordeiles virginianus)*. This bird seems to be uncommon at Windsor, Hants County, N. S. From the middle of May until the end of July, 1892, I only observed two or three individuals. About 8th September, I saw the same number near King's College, but they were doubtless merely migrating southward. The steward of the College told me that in former years they were much less scarce in that locality. Mr. Bishop says that they are common on the "barrens." Near Halifax they are abundant.

KINGBIRD *(Tyrannus tyrannus)*. This bird I found quite common in the vicinity of Windsor and in other parts of the western counties. One day I had an opportunity of observing the great courage of the species. A single Kingbird attacked and turned aside a flock of about forty Crows which was so foolhardy as to trespass upon the domain which he apparently considered to be the property of himself alone. The species is rare in Halifax County.

BOBOLINK *(Dolichonyx oryzivorus)*. The very great abundance of Bobolinks in the western part of the province is a noticeable contrast to the present rarity, or rather absence, of these birds about Halifax. They are without doubt the most conspicuous objects in the ornithological fauna of the flat stretches of dyked land from Windsor westward. When coming from Halifax, the first of these rollicking songsters is met in the vicinity of the St. Croix River, Mr. W. Bishop, formerly of Kentville, informs me that the males arrive in the province between the 15th and 19th of May, and the females about a week later. The first I noted in 1892, were two males on the 18th May. All leave the province between the 5th and the 20th of September. On 18th June, 1890, I heard a single bird singing its unmistakable ditty in a wood not far from my home in Halifax. It was

the first and only time I have personally noted the bird in this locality. My father, Mr. Henry Piers, informs me that about thirty years ago, when grain was grown more frequently than at present in the neighbourhood of this town, Bobolinks were fairly common, after the latter part of August, in the oat-fields near his residence, "Stanyan," Willow Park. About six years ago, he saw seven or eight of the species among some oats in the same locality. They were the only ones he has noted for a long period. Dr. A. H. MacKay says they are rather numerous on the borders of some large streams and meadows in Pictou.

ORCHARD ORIOLE (*Icterus spurius*). On 6th September, 1890, Mr. Austen shot a bird which was doubtless a female of this species, at Shut-in Island, Three-fathom Harbour, near Chezzetcook, Halifax County. The species is not in Downs's list, but it has been taken in the neighbouring province of New Brunswick.

BRONZED GRACKLE (*Quiscalus quiscula æneus*). Up to the year 1888, Mr. Downs had observed only three of these grackles in Nova Scotia. One had been shot at his place in the Dutch Village, the second at Block-house (Stanford's) Pond, Halifax, and the third at Cornwallis, King's County. These were noted in the "Catalogue of the Birds of Nova Scotia." In the fall of 1888, I saw another specimen which he had just purchased. About 15th October, 1893, Mr. Purcell obtained two of these birds which had been shot near Beech Hill, about five miles from Halifax, on the St. Margaret's Bay Road; and about 10th November of the same year, he obtained another from the Sambro Road Mr. Egan has had about three specimens. Mr. Chamberlain says it is "an abundant summer resident from the Maritime Provinces to the Great Plains." As regards Nova Scotia, I think its rarity does not warrant such a statement.

SCARLET TANNAGER (*Piranga erythromelas*). In the spring of about 1873, when raw, chilly winds prevailed, considerable numbers of Scarlet Tannagers appeared in various parts of Pictou County. Such as were taken, were found to be in an emaciated condition, and some were even picked up dead, evidently overcome by cold and hunger. Mr. J. McKinlay, who informed me

of the circumstance, says that, as far as known, no instance of a similar occurrence has since been noted in his portion of the province. Mr. Downs says that a few arrive in the spring, but generally die, and Mr. Bain reports an individual seen by Dr. F. Beer in Prince Edward Island, Mr. Chamberlain's statement that the species "occurs from the Maritime Provinces to the Great Plains, and north to Lake Winnipeg,"* seems not to clearly indicate its general rarity in Nova Scotia. In his revision of Nuttall's Ornithology (v. I, p. 308) he says it occurs sparingly along the Annapolis Valley.

PURPLE MARTIN *(Progne subis).* This bird I found rather common about Windsor, where it bred in boxes erected for the purpose. In 1892, the last individuals were noted on 6th August, and they doubtless left the province not long afterward. The species is rare in the vicinity of Halifax, only a few stragglers being seen in the spring, probably during the migration.

BANK SWALLOW *(Clivicola riparia).* Mr. McKinlay informs me that a *pure white* swallow of this species was seen in Pictou County for three consecutive summers. During the fourth spring, it did not arrive from its winter home, nor has it since been noted. Some southern collector had evidently bagged the unusual specimen.

BOHEMIAN WAXWING *(Ampelis garrulus).* On 16th November, 1893, a male was shot at Porter's Lake, Halifax County. It was mounted by Mr. Egan. This is only the second record of the occurrence of the bird in Nova Scotia. A flock of about a dozen visited us in the winter of 1864-5 (*vide* Downs's Catalogue).

MOCKING BIRD *(Mimus polyglottos).* On the afternoon of Sunday, 30th June, 1889, Mr. Charles A. McLennan, of Truro, N. S., saw a bird on the "interval" at the back of that town, which, from his acquaintance with the species in Virginia, he recognized as a Mocking Bird. He followed it during the whole afternoon. At length, in the dusk of the evening, it retired into

* *Catalogue of Canadian Birds*, p. 93.

an elm which grew on the interval. Next morning (1st July), before daylight, Mr. McLennan was again under the tree, and upon the first movement, fired a charge of shot at the bird. Only one pellet struck, knocking a piece, about one-eighth of an inch long, from the upper mandible. When he saw how slightly it was wounded, he could not resist the temptation to keep it alive. It was a male. Mr. McLennan had it in confinement for about three years, and during the summer it sang constantly. It always was very wild in the cage; keeping its head bald from being frequently thrust through the bars, and its feathers broken or abraded by contact with the sides of its prison. When it died, the plumage was too ragged to make it worth skinning. The only other records of this bird in Canada are, one example taken at Chatham, Ontario, 1860, by Mr. W. E. Sandys, and a pair noted near Hamilton, Ontario, by Mr. McIlwraith in 1883* The identification of the present specimen is utterly beyond question. Mr. McLennan is perfectly familiar with the species, having had opportunities of observing it in Virginia, where he once lived for a time. He has also frequently kept it caged. There is therefore no doubt of the Truro specimen being *Mimus polyglottos*. Many will consider it impossible that the bird would wander so far north, and will no doubt say that it had merely escaped from confinement. This idea, however, cannot be harboured. Mr. McLennan examined it particularly and with an expert's eye, in order to ascertain if such had been the case. "I am convinced," he writes to me, "that it was *not* an escaped cage-bird—in fact, I know it as certainly as I can know anything. Its plumage was unchafed, and its feet were perfectly clean and not perch-marked. All birds which have been caged for the shortest time, have the plumage rubbed on the outer feathers of the wings and the ends of the tail-feathers, and the feet also show very plainly the effects of confinement. To one accustomed to handling birds, I do not think a mistake is possible, and I have had as many as eighty birds caged at one time." He tells me that he now feels he made a great mis-

*Chamberlain's *Catalogue of Canadian Birds*; McIlwraith's *Birds of Ontario*.

take in giving way to his desire to keep the bird alive, instead of making a "skin" of it. In the latter case all incredulity would be at an end. I myself believe that there cannot be the slightest doubt as to the correctness of the record Details, however, have been given for the benefit of those who would not otherwise be convinced.

INSECTS.

CRICKET *(Acheta abbreviata).* On 4th September, 1892, I observed immense numbers of large Crickets *(A. abbreviata*, Harris's *Insects Inj. to Veg.*, p. 152) running and hopping about the grass in the King's Meadow to the southward of King's College, Windsor. They seemed more numerous than the small species *(A. vittata)*, and their *shrilling* was ceaseless. A number of them were observed producing the note. This was done by lifting the wing-covers and then causing them to quiver or shake with great rapidity. The extreme timidity which usually characterizes the species, had been thrown aside, and they paid but slight attention to an approaching footstep, which, at other times, would instantly have caused them to retire into their hiding-places, not to appear again until all danger was past. Beyond preventing themselves from being actually trampled upon, they seemed little or not at all discomposed by my presence, and permitted me to observe them very closely. It was probably the mating season. I had never before seen such great quantities of the insects, and they were still numerous when I left Windsor at the end of September.

IV.—Notes on a Collection of Silurian Fossils from Cape George, Antigonish County, Nova Scotia, with Descriptions of Four New Species.—By Henry M. Ami, D. Sc., F. G. S.

(Read May 14th, 1894.)

INTRODUCTORY NOTE.

The fossil remains herein described were collected by Messrs. Hugh Fletcher and J. McDonald, in October, 1886, at the extremity of Cape George, Antigonish Co., Nova Scotia. In age they correspond most probably with those of Divisions "C" and "D" of the Arisaig Section in Nova Scotia, and to the Niagara and Lower Helderberg of New York State and Ontario. They are therefore referable to the Silurian epoch. Some of the forms examined appear to be closely related to species from various localities in the State of New York, whilst others seem to be more nearly related to well-known European forms of Wenlock and Ludlow age. Those forms, which to us appear to be distinct from both the American and European species already described, are herein briefly described and their characters pointed out.

ANNELIDA.

1. Serpulites longissimus, Murchison. N. var. Under this designation there have been placed the remains of a large annelid which is undoubtedly very closely related to the above Ludlow species of Britain. It attains a great *length* and measures *ten* millimetres in breadth. The surface appears to be smooth, however, in which respects it differs somewhat from Murchison's species. In breadth, the Canadian form is also perhaps less broad, and on the whole may be considered a variety of the European *Serpulites longissimus*.

2. Tentaculites Niagarensis? Hall.

3. TENTACULITES CANADENSIS, N. SP. Shell minute, elongate, very gradually tapering. Annulations thread-like and numerous, there being *seventeen* in the space of *five* millimetres. Intermediate spaces marked by very fine transverse lines, of which there are from six to seven present between two annulations. Diameter of tube at greater extremity: 0.5 mm. Inasmuch as the specimen examined has its apex and portion of the initial portion of the tube broken off, it cannot be ascertained whether this portion of the shell was annulated or smooth.

BRACHIOPODA.

4. DISCINA NOVA-SCOTICA, N. SP. (Form A.) Shell broadly elliptical or sub-circular in outline. Dorsal or free valve very convex. Slope of the shell from the apex to the anterior extremity of this valve, regularly and evenly convex, whilst the slope on the posterior side of the apex, excentric, incurved, pointing posteriorly, and situated at about one-sixth the length from the posterior margin.

Surface of the dorsal valve, black and shining—marked by numerous concentric lines or rounded wrinkles of growth which are crossed by more delicate and very numerous thread-like lines, radiating from the apex to the outer margin. These radiating lines are obsolete or well-nigh so on the apex. Lower or attached valve, unknown.

Dimensions of the dorsal valve of one specimen as follows:—*Length:* 10 millimetres; *Breadth:* 7½ millimetres; *Height* of apex above lower value: 3½ millimetres.

5. DISCINA FLETCHERI, N. SP. Shell almost circular in outline, the diameter but slightly elongated in one direction. Dorsal or free valve very moderately elevated. Slope of the shell from the apex to the anterior margin, broadly and evenly rounded, whilst the slope from the apex to the posterior extremity is gently concave.

Apex excentric, situated about one-fifth the length from the posterior margin and pointing towards the posterior extremity of the shell. Surface marked by numerous lamellar lines of

growth which are crossed by much finer and much more numerous radiating lines which are only visible with the aid of a lens.

Lower or attached valve, unknown. Dimensions of the cast of the interior of a fine specimen, as follows: *Length*, 17¾ millimetres; *breadth*, 15½ millimetres; *height* of the free valve, nearly 2 millimetres.

6. DISCINA ORIENTALIS, N. SP. Besides the two foregoing species of this genus examined from the limestones of Cape George, there occurs also a comparatively small ovate-elliptical form in the collection.

The shell is moderately elevated, and the executric apex is situated at about one-fourth the length from the posterior margin, and forms a curve round from that margin to the side. Surface is marked by obscure concentric lines of growth, and faint radiating lines from the apex.

This form differs from either of the two just described, in being more narrowly elliptical, in the position of the apex, and in its peculiar twisted or curved character, as above indicated.

In some respects it approaches *Discina Morrisii*, Davidson, from the Wenlock limestone of England.

7. LINGULA RECTILATERA, Hall.—There are several specimens and fragments of a Lingula in the collection, amongst which some are tolerably well preserved. They agree in every respect with Prof. Hall's species (L. rectilatera) described in his "Palæontology of New York, vol. 3, p. 156, figured on plate 9—figs. 6 and 8.

8. LINGULA sp.—This form resembles *Lingula perovata*, Hall—described from the upper green (Clinton) shales of Rochester, N. Y. Only one specimen of this species occurs in the collection. It agrees fairly well with Hall's descriptions given of *Lingula perovata*.

9. ORTHIS ASSIMILS ? Hall.—There is the cast of a species of *Orthis* in the collection, which cannot be satisfactorily distinguished from the above as described by Prof. Hall, and has therefore been referred to it, but with some degree of uncertainty.

10. RHYNCHONELLA FORMOSA, Hall.—Possibly this species, or else a very closely related one. The specimen in question, though imperfectly preserved, presents such characters as make it agree well with the descriptions and figures given by Prof. James Hall in his "Palæontology of New York State," vol. III., p. 236, figs. 6, a-y, on plate XXXV.

LAMELLIBRANCHIATA.

11. ORTHONOTA EQUILATERA, Hall. sp. *Tellinomya ? equilatera*, Hall, and *Tellinites affinis*, McCoy, are very closely related to each other. One form abounds in the Lower Helderberg rocks of America, whilst the other is not unfrequent in the Ludlow rocks of Britain. The characters of both species agree very well, and the Cape George specimens resemble the figure of *Tellonomya ? equilatera*, Hall, so much that they have been provisionally referred to this. The Canadian specimens are somewhat smaller than the New York specimens.

12. MODIOLOPSIS EXILIS ? Billings. A form which agrees tolerably well with Mr. Billings's species from the Arisaig Silurian rocks.

13. NUCULITES (CLIDOPHORUS) ERECTUS, Hall.

14. NUCULITES, sp. INDT. This form is most probably a Nuculites; but is too imperfectly preserved for specific identification.

GASTEROPODA.

15. BUCANIA sp. A species of Bucania referable to *Bucania profunda*, Hall, seems to be present in the collection.

16. HOLOPEA REVERSA, HALL.

CEPHALOOPODA.

17. ORTHOCERAS sp., cf. O. annulatum, Sow. This is a well-known Wenlock limestone species in Britain, and a Silurian form in America

18. ORTHOCERAS sp. indt. An imperfectly preserved specimen which cannot be referred with certainty to any species already described. Nor is it sufficiently well preserved to warrant describing as new. The septa however appear to be closely

arranged, there being some *fourteen* of them visible in a length of *twenty-two* millimetres.

OSTRACODA.

19. LEPERDITIA sp. There are several specimens of a small reniform species, 1.5 mm. long and 0.6 mm. broad. Rather tumid, and sharply rounded at both the anterior and posterior extremity.

VERTEBRATA.

PISCES.

20. ONCHUS (?) sp.—Two or possibly three spines or organs of defence of one of the earliest types of vertebrates appear to be present in the collection. They are tolerably well preserved, and present no salient features. Cross-section, sub-circular to rhomboidal. Longitudinally, these spines are nearly straight, and, being broadly and very gently curved in two directions, gradually taper from the base to a more or less acute point.

Dimension.—Length of one of these spines (which is slightly imperfect), *ten* millimetres ; breadth, *one* millimetre.

Additional note on the Fossils and the horizon they indicate.

These fossils from Cape George seem to indicate a zone or horizon which differs considerably from those of the Arisaig Coast collected by Mr. Weston in 1886, and which have also been examined. This is probably due to local causes

The presence, in tolerable abundance, of shells of the genus *Discina* is in itself quite characteristic, and a fact to be noted. Besides the twenty forms described or enumerated in this paper there are numerous fragments and obscure remains of fossils which, although too imperfect for specific identification, nevertheless may serve to point out the occurrence and association of the following genera. They are: Lingula, Strophomena or Chonetes, Rhynchonella, Retzia, Murchisonia, Homalonotus ? The presence of a number of Ludlow and Lower Helderberg fossils tend to indicate an horizon well up in the SILURIAN SYSTEM.

HENRY M. AMI.

Determined at Ottawa, June, 1887.

V.—Notes on Recent Sedimentary Formations on the Bay of Fundy Coast.—By R. W. Ells, LL. D., F. R. S. C., &c.

(Read May 14th, 1894.)

Ever since the commencement of the study of the rock formations in Nova Scotia and New Brunswick, nearly sixty years ago, the red sandstones and associated trap rocks, more especially seen along the south side of the Bay of Fundy, have been regarded as the newest member of the geological scale, and presumably of Triassic age. Along the north shore of the Bay, in New Brunswick, small isolated areas of similar rocks occur at several places, but the red cliffs of Cape Blomidon, and the several points in eastern Kings County which project into the waters of the Basin of Minas may be taken as typical of the sedimentary portion of this formation for this area.

On the north side of the Basin scattered outliers of Triassic sandstone also appear from Partridge Island eastward. As we approach the upper part of Cobequid Bay these become more extended and form a band along the north shore of several miles in breadth which extends from the head of the Bay along the valley of the Salmon River for some distance east of Truro. The most prominent feature connected with this formation however is the great ridge of trappean rock, which, rising like a wall, several hundred feet in height, cuts off the lovely valley of the Cornwallis and Annapolis Rivers from the waters of the Bay of Fundy. The debris of these trap rocks, when mingled with the red loam of the valley, has produced a soil especially favourable to the growth of apples and other fruits, and the same peculiar soil is found in the finest orchard centres of the Province of Quebec, such as the district surrounding the trappean mountains of Montreal, Abbotsford, St. Hilaire and Rigaud, the soils of these localities from the destruction of

the trappean rocks being apparently very similar to those found in the Annapolis Valley, and being also favourable to the growth of fruit trees.

The extension of the trap ridge of Kings County to the eastward is seen in a scattered group of islets known as Five Islands, and Partridge Island, near Parrsboro, while to the west the bold bluffs of Capes Sharp and d'Or, and further down the Bay the cliffs of Isle Haut represent further outbursts of similar igneous rocks along the northern margin of this area of disturbance and volcanic activity.

The relations of the volcanic rocks, generally known as Trap, to the associated sandstone are well seen at several points, and from the study of these it would appear that the former is the more recent. The intrusion of the volcanic into the sedimentary is clearly seen, and the sandy layers along the contact are not only pushed upward on either side of the dykes, but the red rock is metamorphosed to a certain extent, as seen in the discoloration of the beds and by their alteration to a more quartzose condition. In fact the whole range of the North Mountain is practically only an immense sheet or overflow of igneous rock which has issued through a line of fissure, traversing both the red Triassic beds and the underlying Carboniferous strata, and spreading out northward in the direction of the waters of the Bay of Fundy. This trap ridge consists of a series of layers of various kinds, in which are found heavy columnar rocks, forming pillars as regularly shaped as those of the Giant's Causeway. These can be well seen at various places along the north side of the promontory between Capes Blomidon and Split. Other layers are ashy and soft, others again reddish and felspathic or amygdaloidal, and certain beds contain masses of beautiful zeolites, amethysts and agates, which have caused this belt of rocks to be celebrated far and wide among mineral collectors.

At several places along the Bay of Fundy shore of the North Mountain, the trap, which for the most part forms an unbroken wall for seventy miles, is overlaid by newer sedimentary beds. Probably the most conspicuous deposits of these are situated a short distance west of Scot's Bay. One of these is well seen in

a small cove known locally as Ira Woodworth Bay, and from some notes, taken at this place during a hurried trip along the shore in 1876, the following points of interest may be stated for the purpose of stimulating further investigation on the part of those students more particularly interested in the study of the geology of the district.

At this Bay the trap rock is very amygdaloidal, and a small cove about forty rods across is hollowed out of the shore line. The cliff here is quite low, the erosion having been very considerable, and the amygdaloid is overlaid by a green sandy looking shale about four feet in thickness, having a dip to the south east of about ten degrees. This is in turn overlaid by a greyish sandy calcareous rock which is interstratified with beds of nearly pure limestone. Certain bands of the series hold concretionary masses, often of large size, of jasper and chert, which frequently contain beautiful crystals of amethyst. The thickness of the calcareous beds exposed at this place is about ten feet, and the whole is covered by soil. The purer calcareous layers have been locally burned for lime and the stone is said to have yielded an article of very fair quality.

Admitting then the Triassic age of the soft red sandstone and the more recent age of the trappean rocks which have broken through these, it would follow from the superposition of the beds just described upon the latter, that these limestones and shales must be of still more recent date. No fossils have however yet been found at this locality, probably through lack of search in this direction. It may be of interest to note in connection with this that greyish calcareous sandstone and impure limestone have been recently noted by Prof. Bailey in association with the trappean rocks of Digby neck. In these, impressions of plant remains were clearly visible though the species are as yet undetermined. Should these rocks prove on examination to be similar to those of Ira Woodworth Bay, the formation would appear to have been at one time quite widely distributed.

The occurrence of these recent rocks is of very considerable interest, geologically speaking, and from their proximity to the

educational institutions at Wolfville they could be readily examined by the scientific staff of that University. This would be very desirable so that the presence of fossils, if such exist, may be recorded and the age of the strata in question fully determined, seeing that they represent, in so far as our present knowledge extends, the highest group of stratified sedimentary rocks in Eastern Canada.

VI.—Deep Mining in Nova Scotia.—By W. H. Prest.

(Read 14th May, 1894.)

This is a subject fraught with deep interest to the mining men of Nova Scotia, a subject touched upon, theorized upon, or slighted, but never, so far as my opportunities for knowing go, examined from a thoroughly geological standpoint. Comparisons with other mining countries have been made, which have so far brought forth no definite conclusion, because the different geological conditions connected with the origin of each have not been taken into account.

Having waited for several years for the published opinion of some older and more experienced miner and geologist, I at last venture to give my views on the subject. They are the results of several seasons of geological survey work, as well as a previous practical experience in gold mining.

It has been a stock argument in the dispute "Deep *versus* shallow mining," that as deep mining is prosecuted successfully in other countries, it is reasonable to suppose that the same result would follow here. This method of argument should now be out of date. The point is, not that the inference is wrong, but that it should be based upon a different set of facts.

The old method of drawing conclusions in Nova Scotian lithology from arguments based on the study of foreign geological conditions is only leading us farther and farther from the true method of investigation. We must not forget that the geological conditions under which foreign mines came into being are usually different from the conditions pre-existing here—a consideration which renders useless the direct comparisons very often made. In order to arrive at any safe conclusions regarding the depth to which our pay streaks run, it is necessary to thoroughly understand the peculiarities of our auriferous rocks, their origin, and the different stages of world building in which they have aided. The geological history of each formation, and also of each

gold district, should be studied under the full conviction that different causes give different results, and also that the same causes in different circumstances often give different results.

Deposition.

In order to consider to advantage the question of deep mining it is necessary to begin with the geological history of the formations we propose to discuss. From a knowledge of their origin and the progress of events connected with their evolution, we may then arrive at an intelligent conclusion in regard to their future possibilities.

The geological position of the auriferous formation of Nova Scotia rests upon both stratigraphical and fossil evidence, neither of which, I am sorry to say, is very decisive. Such fossils as the Eophyton and Asteropolithon (the latter of which with several other forms I have found east of Moose River mines), seem to place it in the lower Cambrian. Calcareous or dolomitic layers have been discovered, which would indicate the presence of fossils; but so far they have proved barren. The want, however, of distinct fossiliferous evidence has made its correlation with any foreign series a matter of great difficulty. Faribault, of the Dominion Geological Survey, from lithological comparisons inclines to the belief that the gold-bearing formations of Nova Scotia belong to the same horizon as the gold-bearing rocks of Quebec. Other observers have regarded them as an equivalent of the Olenellus beds of New Brunswick. The most important points to be noted in connection with the age of these rocks are, their immense thickness, the almost complete absence of fossils and the apparent deep sea origin of their upper beds. The thickness of the quartzites and slates, as estimated by me on the Sissibou last summer, is over 25,000 feet. At Molega, Queens Co., the quartzite alone shows about 15,000 feet. At Mt. Uniacke the thickness is about the same. It seems hardly possible that this great thickness belongs to the Lower Cambrian; but there is so far no evidence that it belongs to any other horizon. We would naturally expect to find fossils in the transition from the quartzites to the argillites which marked

the age of a slowly deepening sea, but only a few uncertain forms (probably concretions) have been found. The nature and order of the deposits of this formation are clearly shown in different parts of the province, but most completely so on Kejama-kuja Lake and the Port Medway and Sissibou Rivers. The succession of its beds is given below and a very rough estimation of thickness (made in the absence of notes), accompanies it:

1.	Lower bluish-grey quartzite	6,000
2.	Bluish-grey quartzite with plumbaginous slate	2,000
3.	Upper bluish-quartzite with bluish-grey slate	3,000
4.	Bluish to greenish-grey quartzite and slate of same co'our	5,000
5.	Lower greenish-grey slate	1,000
6.	Lower purple slate	150
7.	Middle greenish-grey slate	1,500
8.	Upper purple slate	400
9.	Upper greenish-grey slate	1,000
10.	Bluish-grey and ribbanded slates	500
11.	Bluish-black slates	2,000
12.	Black slates with white arenaceous seams	1,500
13.	Blue and bluish-grey slates	2,000
	Total about	26,000 ft.

I may have occasion before long, from evidence lately seen, to add another intercalated member to the list.

It must be remembered that the sequence is not the same in every district. In some of the eastern districts, the upper or lower purple slates or both are absent. In some of the western districts the plumbaginous slates are absent. We can, however, be certain of one fact in this connection, viz: the order is never reversed. The lowest bluish-grey quartzite is shown only in our very widest anticlines, particularly at Dollard's Lake. The plumbaginous slates are seen on or near the anticlinal apex in many of our eastern, but not so generally in the western, districts. No. 3 is specially developed on the Sissibou; No. 4 at Mt. Thom in Musquodoboit; No. 5 in Queens and

Yarmouth Counties; Nos 6 and 8 on the east shore of Keja-ma-kuja lake; Nos. 10, 11 and 12 around Lunenburg town; Nos. 11 and 13 on the Sissibou and north of Caribou mines. The thickness of the different beds is very variable. A member having a thickness of 2,000 ft. in one district may thin out to 200 ft. or less in another district. While the lower portion containing the greatest thickness consists of quartzites and arenaceous slates, the upper part is composed of argillites, the transition being in the green and purple slates. This vast thickness of argillites, which in other countries often contain great quantities of fossils, is here nearly barren, if not completely so. The supposed fossils before mentioned are found principally in divisions 3 and 4. The Lower Cambrian purple and green slates of Wicklow, Ireland, contain the fossil plant, Oldhamia; but whether our purple and green slates resemble the Irish beds in anything but colour, it remains for future research to decide.

That the highest slate beds once covered the lower strata completely, there is much evidence to show. There is no spot to which we can point and say: "Those undoubtedly were *always* the highest beds in the gold bearing series." There is no spot of which we can say: "Denudation has been very limited here." No upper series limits the upward reach of the highest beds of the auriferous formation

Even where the highest strata are seen, indications point to still higher beds. On the Sissibou, at Weymouth Bridge, is the apex of an anticline showing some of the lowest beds in the series. Seven and one-half miles to the south-east are the highest beds in the same series, with a thickness of over 25,000 ft. of conformable strata between them. Thus, the centre of this immense ridge, after folding, was many thousands of feet above the trough of slates to the south-east.

Now is there any place where such a trough has been formed and exists in modern times unfilled with still higher beds? It may be said that the ridge may not at any time have been very high, nor the resulting synclinal trough very deep, as denudation may have kept pace with elevation. But, in this case, it must be remembered that deposition always keeps pace with denu-

dation; so that where a trough exists it could not fail to be filled with the results of the erosion of an adjoining ridge. The softness of those upper slates would also guarantee the formation of a trough under ordinary erosive conditions. A considerable elevation also seems to be necessary to such an immense denudation, confined as it is to the comparatively short time to which it must be limited. At any rate the evidence seems to justify the conclusion that there once existed higher beds, conformable to our auriferous series as well as superimposed deposits of a later age, all having since vanished through erosion.

Folding.

The folds into which our gold-bearing rocks are crumpled, may be roughly divided into three classes, which merge gradually one into the other, viz:—circular domes, ellipses and parallel ridges. The first and second only are found in the western counties; the second and third in the eastern counties. The most perfect example of the first is to be seen at Pleasant River Barrens, Lunenburg Co., while the greater part of the western mines belong to the second. Very good examples of the last are seen in eastern Halifax County, where 3 or 4 anticlines lie parallel for over 30 miles, and include the following auriferous localities. Beginniug on the north, we have on the first fold, Dollard's Lake, Mt. Thom, Moose River, Cope's Hill, Beaver Dam and Fifteen Mile Stream; on the second, Gold Lake, North Mooseland and Killag; on the third, Cowan's Brook, South Mooseland and Lochaber. These parallel folds are sometimes cut by short sharp cross synclines or slight depressions, which, however, do not interrupt their continuity to any extent, as at Moose and Salmon Rivers.

In the western Counties, these cross-synclines are always broad and deep, often containing beds as high in the series as are found in the main synclines of Halifax County. The result is that the anticlinal domes are irregularly disposed, and the theory of "ranges," so common in the eastern Counties, is not at all applicable to the western districts.

Another distinguishing feature of the western counties is the existence of a multitude of minor folds intermingled with the larger gold-bearing anticlines. This is noticed particularly in the coast and central districts of Lunenburg Co. In Halifax and Guysboro' Counties we have very few of these minor folds.

Now let us consider the cause of this difference of form shown by the folds of the eastern and western Counties. We see the eastern folds, long, narrow, parallel, and steeply inclined, occupying a part of the province comparatively distant from continental influences, pent between the ocean and the Pre-cambrian of the Cobequids, and subject to lateral forces from the north and south, but free to prolong their eastern extensions indefinitely. Thus we can trace in their conformation and position the formative influences that gave them birth.

The western folds short, broad, distributed irregularly, and less steeply inclined, were more within the sphere of continental influences. Thus we see them acted upon in a lesser degree by the same forces as in the eastern counties, but also strongly influenced by a centre of resistance on the west. This centre, apparently the Adirondacks, was also the cause of the elevation of the older rocks of the north-eastern states The domes and ellipses of the western counties show the effects of this additional pressure in various ways:

1st In the gradually increasing south-westerly trend of the ellipses as we go west;

2nd. In the deeper and wider cross synclines;

3rd. In the rounder forms of the domes, showing a more equalized pressure;

4th. In the great prevalence of north and south, and the absence of east and west, faults;

5th. In the gradual south-westerly trend and parallelism of the trough-like depression of the Bay of Fundy.

As to the time when this folding took place there is no precise information. It is, however, definitely limited by, and older than the granite metamorphism of Lower Devonian times. The Oriskany of Bear River is thought to be folded in by the Cam-

brian slates. But the fact that it shows a syncline even steeper than the Cambrian syncline, which surrounds and encloses it, seems to point to conformability, or at least to deposition, on nearly the same plane as the lower slates. To those who are geologists I give this problem:—The centre of the syncline, supposed on fossil evidence to be Oriskany, with a dip of from 70 to 90, is folded in a syncline of supposed Cambrian slates, dipping from 50 to 70. Could the former have been deposited on the upturned and denuded edges of the latter and then folded to such a dip by the farther crumpling of the lower system? Would it not rather indicate that the lower slates were not yet folded when the Oriskany was deposited on them, and that both were folded simultaneously in Lower Devonian times? And yet we know that between the folding of the lower slates and the deposition of the Lower Carboniferous conglomerate, there has been an erosion of those slates and quartzites to the depth of over 20,000 ft. The supposition of unconformability seems untenable; and yet the theory of conformability confines this immense denudation to the Devonian age.

There is evidence in the eastern part of the Province to show that a considerable interval elapsed between the folding and metamorphism of the auriferous rocks. At the west end of the Mooseland anticline, near its junction with the granite, the cleavage lines are seen enclosing thin dykes of granite Therefore the time elapsing between the two events was sufficient to allow lateral pressure to increase and show its presence in the fully formed cleavage lines now seen there. The points above discussed, I hope to obtain more information upon during the coming season.

MINERALIZATION.

The distribution of gold in our auriferous veins is often designated by the terms spotty and streaky. The first is the special peculiarity of the Yarmouth County mines with their wandering maze of angulars and cross leads and their inconstant slate-bound main-leads, as at Kempt. The uncertainty in this case seems to be rather the pinching out or decrease in the

amount of quartz than the complete absence of gold Of the streaks we will speak farther on.

The mineralization of our gold-bearing leads seems to have taken place during the folding process and before the formation of the cleavage planes. The different seams composing them show a somewhat interrupted mode of formation while polished and striated surfaces show that the folding and consequent earth movements were not complete when the deposition of vein matter began. Those veins were of course then far below the surface of the folds. The auriferous zone of Mt. Uniacke for instance was over 20,000 feet below the upper slates, and could one of our pessimists have been there at that time he would have declared that no gold existed there, and that deep mining was useless.

The hydro-thermal theory of the origin of mineral-veins now so widely upheld and based on so many well known facts accounts (as far as my opportunities for knowing go) for every peculiarity of our gold-bearing leads. The hot springs of California and the Yellowstone Park in which many minerals are now being precipitated reach down without doubt to the great internal source of heat and are active examples of the hydro-thermal mode of mineralization. If this theory accounts for our pay streaks, which is very probable, I see no reason why they should not reach down as far as it is possible for mining to be carried. We have in Nova Scotia men who while convinced of former hydro-thermal action in our auriferous veins, yet give voice to the idea that they are, comparatively speaking but surface deposits.

METAMORPHISM.

To the metamorphic influences of the early Devonian must we ascribe the origin of the gneisses, schists and diorites and much if not all of our granite. We may define the granite as the molten nucleus by which the metamorphosis of our Cambrian and Silurian rocks was brought about or we may class it as a result of the fusion of our stratified rocks. The latter seems to

be the more probable theory being supported by testimony from all parts of the Province. For example the fossiliferous, Oriskany, syncline of Bear River passes without a change of dip or position into the granite on the west and re-appears with the same fossils and dip and in the same range, a few miles further on at Mistake Settlement, near the Sissibou. The eastern extension of the same syncline passes into the granite to the east by the same gradual metamorphism and re-appears to the south of Annapolis town as a half metamorphic slate. The gold-bearing leads and rocks of Mooseland pass in numerous places into the granite, the lines of stratification gradually fading away as crystallization increases. At Hubbard's Cove, Lunenburg Co., the original bedding lines are distinguished for some distance from the quartzite. To the gold miner one important result of this period of metamorphic activity are the fractures caused by the subsequent shrinking of the fused districts. These are seen at Sherbrooke, Mooseland, Mt. Uniacke, Newbern in Lunenburg County and other places.

To summarize some of the foregoing notes, the events traceable between the deposition of the auriferous rocks and their metamorphism, are as follows:—

1st. Folding of the gold-bearing series.
2nd. Formation and mineralization of leads.
3rd. Formation of cleavage lines.
4th. Deposition of the Oriskany of Bear River.
5th. Farther folding of both series.

This order may. nowever, be altered by a decisive solution of the problem given on page 426.

DENUDATION.

Before enquiring into the results of erosion let us understand thoroughly the condition of the surface before erosion began. The upper strata, as far as denudation has left them, are the bluish-grey slates, now seen at Lunenburg and the Sissibou River. There may have been still higher strata (see page 423), but the tremendous erosion to which the Province has been

subjected prevents our knowing anything on this point. However, there is enough left to show that the original surface of the larger folds would on an average be nearly 25,000 feet above the present surface. Denudation is shown best on the Sissibou River, Mt. Uniacke, Dollard's Lake and Molega. On the Sissibou where the greatest width is shown erosion has laid bare a section over 25,000 feet thick.*

Of the vast erosion of the Cambrian rocks by far the greater portion is Pre-Carboniferous. The evidence for this is seen in Newport, Musquodoboit, Gay's River, Carrol's Corner and other places. At each of these places the Lower Carboniferous is seen overlying the slates and quartzites which have already been eroded to a depth, in some places, of over 20,000 feet. Near the head of St. Mary's Bay, Digby County, the bulk of the evidence seems to show that the Triassic sand-stones were not deposited until the Sissibou anticline had been eroded to almost or quite its present depth.

If, as has been maintained, our granites were crystallized under great pressure, then the Cambrian slates were at most only slightly eroded when the early Devonian metamorphism took place; otherwise the granite would be deprived of that immense weight necessary to its crystalline form. Under this supposition this immense denudation would all be included in the Devonian age. Even if this supposition was swept aside, the incontrovertible fact still remains that only to the interval between the Cambrian and the Carboniferous can we refer nearly the whole of this stupendous operation.

The bearing of this fact on the question of deep mining is this—viz: that even in Pre-Carboniferous times denudation had already exposed the lowest observable strata of our gold fields and had carried on deep mining to a depth of over 20,000 feet, laying bare the pay streaks which have often been asserted to be only surface deposit

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*A summary of my notes on the Sissibou section is as follows:—

From anticlinal apex in blue quartzite up to purple slates 3⅜ miles. From purple slates to fossiliferous slates or beds immediately underlying them 2⅝ miles. Total 6 miles. Average dip 321° 30′ at an angle of 65°. Resulting thickness (at right angles to bedding) 28,723 feet.

However, to cover all possible errors of measurement, unseen faults, &c., I strike off over 3,000 feet.

Of Post-Carboniferous denudation the greater part seems to have taken place in Pre-Triassic times; but as this does not seem to have affected the auriferous rocks to any great extent, I shall pass it.

The "Great Ice Age" of Post-Tertiary times once occupied in text-books a prominent position as an erosive agent, but the investigations of modern glacialists seem to have limited its action considerably. The denudation of the Lower Carboniferous of Musquodoboit and the Triassic sandstones of the Annapolis Valley reaching through Mesozoic, Cenozoic and Glacial times is, as far as my observations go, limited to a depth of not over 300 feet. How much of this can be ascribed to the Glacial age is impossible to determine. Unless the "Great Ice Age" has removed a former carboniferous covering from the auriferous rocks I can see no indications of extensive Post-Tertiary ice action over southern Nova Scotia.

Classification of Mines.

Our gold mines are of three classes:

1st. Those consisting of bedded or main leads.

2nd. Those consisting of cross or fissure leads, or whose gold-bearing main leads are mineralized from fissure leads.

3rd. Those consisting of gold-bearing drift or conglomerate.

Those of the 1st class reached no higher than their junction with the apex of the anticline, and were covered by the upper beds before denudation was carried that far. To this class belong the most of our gold mines and auriferous localities.

Those of the 2nd class cutting across quartzite and slate alike, and not controlled by anticlinal influence, were probably first uncovered by the denuding agencies. To this class belong the mining localities of Brookfield and Broad River, Queen's County, West Rawdon, the Lake lead of Caribou, Upper Cornwall, Lunenburg County, the Kempt mine, Yarmouth County, and probably South Uniacke and a few others. Those of the 3rd class are the results of the erosion of the 1st and 2nd class. They denote that the upper part of a gold-bearing zone has been removed,

but do not mean that it has totally disappeared through erosion. To this class belong the Ovens, Gay's River and Brookfield, Colchester County.

The Eastville mine of South Uniacke seems to belong to the 2nd class, but is on the same geological horizon as the 15 Mile Brook, Queen's County, and Carleton, Yarmouth County. There are indications that the Eastville pay-streak intersects a cross-lead, at the junction with which its richest spot may be found.

DEEP-MINING PROBABILITIES.

A supporter of the theory that our mines are only surface deposits is unfortunately also committed to the following ideas:

1st. That our pay streaks were formed originally in the centre of an immense mass of barren rock without connection with either the original surface or the mineralizing influences of the earth's interior.

2nd. That the erosion of from 10,000 to 25,000 feet from our gold-bearing anticlines was carried only just far enough to lay bare the best spots in each district For example, the removal of 10,000 or 12,000 was needed to lay bare the richest part of the Caribou veins. It was done as needed. Nearly 25,000 feet of erosion was needed at Mount Uniacke. That was also done to order. About 20,000 or 22,000 needed removing in Molega to accommodate our miners. That also was done in the most obliging manner.

3rd That the erosion of a thousand feet more would sweep away forever all the gold mines of the province. For example, erosion to the depth of 23,000 instead of 22,000 in Molega would have left only a few barren leads. An erosion of say 13,000 instead of 12,000 would have done the same for Caribou.

4th. That the denudation of a thousand feet less would have hidden our gold completely, or rendered deep mining necessary in order to reach it. Considering that different amounts of rocks had to be removed from each district in order to reach the auriferous zone, the probabilities for such generosity on the part of the denuding agencies are exceedingly doubtful.

The position of our gold-bearing zones in regard to the anticlines are as follows:—48 are on or very near the apex of anticlines; 11 are from ¾ mile to 3 or 4 miles from the apex, with a few of uncertain position.

It must be remembered that the proximity of a lead to the anticlinal apex is no certain evidence that it is gold bearing. Its position in regard to the apex is simply a geological accident depending on the size of the fold and the amount of erosion it has suffered. For example, we can see that had erosion not extended so far the auriferous zone of Renfrew would have been nearer the anticlinal apex, while Mount Uniacke, Caribou, Goldenville and numerous others would have been hidden from sight beneath their anticlinal coverings. Again, had erosion been carried several thousand feet deeper the gold bearing zone of Renfrew would have been removed much farther from the apex than it is now, while Caribou, Goldenville and Mount Uniacke would probably have borne the same relation to the apex that Renfrew now does.

Or, to explain my meaning more thoroughly, Mt Uniacke, according to an old survey, has a north dip averaging 60°, and a south dip averaging 90°, and an anticline inclining north about 75°. Assuming that the paying leads extend 600 ft. south of the apex, they would meet and fold over it at a height of 2,318.2 feet. However, as the sharpness of the apex generally decreases with its increase in geological height, the leads would curve over the anticline and be covered by succeeding layers before reaching the height mentioned. An auriferous zone which was once hidden from view in the depths of the anticline is first laid bare by denudation, and then removed farther and farther from the apex with every successive period of erosion. Therefore the distance to which the auriferous zone has been removed from the apex of the anticline marks the stage to which denudation has been carried. That the distance to which a lead has been removed by erosion has nothing to do with its poverty or richness is seen in Renfrew, South Uniacke, Whiteburn and Kempt That the depth to which it has been eroded does not mark its richest spot is shown by the fact that an erosion of 10,000 or

12,000 feet in Caribou has reached a paying auriferous zone, while an erosion of about 25,000 feet in Mount Uniacke has not gone beyond it. Between those limits lie the paying portions of the gold-bearing zones of nearly all the other mines.

Some facts showing the existence of rich spots both above and below the present surface are as follows:—

At Killag, by far the richest parts of the leads have apparently been swept away. At Fifteen Mile Stream the richest parts of the Orion and Serpent leads have been carried away. The same may be said of the Cumminger lead of Mooseland and the Prest lead of Upper Cornwall and many others. Other rich spots have been reached only by deep mining, as for instance in the Stuart mine in Caribou.

Our deepest mines have reached a vertical depth of not much over 400 ft., the pay streak where present, being followed on an incline of course considerably farther. Some, like the Lake Lead of Caribou, once considered worked out, have been again attacked under new and energetic managers and promise a bountiful return for the future.

A reconsideration of the evidence as far as I have been able to collect it, seems to justify the following conclusions:

1st. The probability of the hydro-thermal origin and resulting great depth of our mineral veins and pay streaks.

2nd. That the original was far above the present surface and even the upper beds of the series in question show evidences of great erosion and still higher beds.

3rd. That what are now called surface deposits were then many thousands of feet deep.

4th. That denudation (or geological deep mining) has already exposed our pay streaks to a depth of 25,000 ft. below the original surface.

5th. And finally, modern mining has only exposed those pay streaks 500 or 600 ft. lower down, thus only slightly extending the former geological work.

When the question of deep mining is fully considered in all its varied geological relations, I cannot see why there should exist any doubt as to its successful prosecution. Judging future

mining from past geological work there is no evidence that our auriferous leads either decrease in size or richness with increasing depth. The cost of mining certainly increases with depth, but should not increase at a greater ratio than in foreign countries where a few dwts. per ton, often pay a dividend. Why is it that moneyed men will without any hesitation invest largely in manufacturing industries in the face of competition and the frequent possibility of a glutted market? The gold market is never glutted, neither is there the slightest evidence of the supply being exhausted. But the gold mining industry like all others needs capital, scientific knowledge, and a talent for hard persevering work, very little of which has so far fallen to its share. Money is doled out in hundreds instead of thousands. A special course of training on the peculiarities of our auriferous formation is unattainable, and the want of confidence which results in lack of perseverance is a natural outcome of the want of special knowledge and financial backing. We want foreign mining engineers among us if only for the purpose of infusing into us some of that vigorous though venturesome policy that showed itself in the construction of the Comstock tunnel in the hope of a final reward. Something of this energy has shown itself lately in the piercing of the anticline at Oldham by Mr. Hardman, and the renewal of work on the 500 ft. shaft on the Lake lead, Caribou. The sinking of the deep shaft by Mr. Hayward at South Uniacke is also a sign of the revival of mining enterprize in Nova Scotia.

Years have been wasted in begging the Government for aid in sinking a thousand foot shaft to solve the question of successful deep mining, but had one quarter of the money lost in unsuccessful manufacturing enterprises been applied to the purpose the problem would have been solved long ago.

VII.—NOTE ON THE SYDNEY COAL FIELD.—BY E. GILPIN, LL. D., F. G. S., *Inspector of Mines.*

(Received Nov. 2nd, 1894.)

In this note it is proposed to draw attention to the presence in the Sydney coal field of a subordinate basin. The existence of the basin was indicated by the officers of the Geological Survey in their reports, but its extent has been more clearly defined by recent explorations. The survey of Mr. Fletcher showed that a line of fault runs from Sydney to the Mira River, near the mouth of Black Brook. More recent examinations have shown that this fault diminishes in extent as it is followed to the south. At the town of Sydney it brings up measures referred to the carboniferous limestone, and the section as exposed is probably directly connected with the rocks of the same horizon on the west side of the Sydney River. At this point the denudation of the uplifted measures has exposed these strata. As the distance from the point of maximum upheaval increased the limestone series was covered by a gradually increasing thickness of millstone grit until in the trough lying against the line of fault measures appear belonging probably to the top of the millstone grit or the lower part of the productive measures.

When the line of the fault reaches the MacPherson road it appears to have become much reduced in extent. Beyond this its passage is shown on the Morrison road by springs and rough ground. It may be inferred that its line here lies a little to the eastward of that marked in the geological survey plan. It is not known if it is a dislocation in this vicinity or only an anticlinal.

The Cossitt basin lies to the south-west of this fault. Along the eastern side of the line of fault the measures, wherever noted, have a low and regular dip to the north-east, and agree with those observed in the Glace Bay district. On the west side of the fault the dips are to the south-west at heavy angles, and on approaching within a mile of the town of Sydney the line of steep dip turns in a semicircle round to the west, limiting the

coal basin in this direction, and between this line of outcrop and Sydney is an interval of disturbed strata. From the line of fault to the centre of the Cossitt basin at the synclinal the distance varies, but may be roughly estimated at about one mile. The dips over this interval decrease from 46° to 20°, and shortly before the synclinal is reached three seams have been exposed dipping to the south-west at an angle of 30°, and yielding the following section :—

	Feet.	Inches.
Coal	2	0
Strata	100	0
Coal	2	0
Strata	20	0
Coal	2	0

About three-quarters of a mile further to the south-west are met the LeCras seams, dipping the reverse way, or to the north-east, at an angle of 7°. Here the following section has been proved :—

	Feet.	Inches.
Coal	1	10
Strata	100	0 ?
Coal	2	2
Shale	0	8
Coal	0	2

This evidently corresponds with the seams found on the reverse dip and already alluded to. From this point the western outcrop of these seams runs in a south-easterly direction parallel to the Mira road and crossing the Morrison road a little to the east of its junction with the Mira road, and continuing until Black Brook is nearly reached. At this point the south-western side of the basin appears to be turning to the eastward, possibly showing that the end of the basin is reached, and that the strata are falling in with the normal dip of this part of the district which is a little to the east of north.

To the south of the Morrison road, nearly five miles from its junction with the Mira road, several outcrops of seams have been

opened dipping at an angle of about 20° nearly east. The course of these seams, allowing for the presence of the fault as an anticlinal, may bring them into range with the continuation of the LeCras seam, in which case the seams of the east side of the Cossitt Basin would curve round to the eastward at McPherson's road and become conformable with the measures underlying the Glace Bay coal seams. If, however, the fault be present in any magnitude then these seams would continue in a north-westerly course along the east side of the fault, leaving the seams in the Cossitt Basin isolated. The increase in dip of the Murray seams over the normal dips hitherto observed in this vicinity may be due to an anticlinal character here of the fault already described, which may be found to pass a short distance to the south-west of these seams.

One of the problems of this coal field is the Tracey seam. This bed of coal occurs very low down in the measures, many feet below any seam hitherto worked. It is known only at False Bay between the head of Cow Bay and Mira Bay. Here, emerging from the Atlantic, after a land course of about one mile it is lost again in the False Bay Lake. Here it was opened and worked a number of years ago, and is said to be of fair quality. The extension of the outcrop of this seam into the district lying between Cow Bay and Sydney has been the dream of many a prospector, and has led to an expenditure of much money, producing only negative evidence. The theoretical production of its outcrop, as laid down by Sir William Dawson, the Geological Survey and others, would bring it not far from the Murray seams. The subject, while interesting geologically, is not without a practical value, for owing to the prevailing low dips, the seam would be accessible over a wide expanse of country if it preserves a size admitting of economic mining.

The identification of the Tracey seam with the Murray seams and their further identification with those of the Cossitt Basin will prove an interesting subject.

There is another point of interest in connection with the Cossitt coal field. A collection of fossils from one of the openings on the LeCras seams was submitted to Sir William Dawson

who remarked, "that it was composed principally of leaves pressed in grey shales and remarkable for furnishing several species of ferns with the fructification. The horizon is stated to be that of the millstone grit, but the determination of the plants would not convey that impression, being of species not occurring elsewhere except in the coal formation, and even in the upper part" He further remarked that a similar group of plants appears in a collection made at Henderson's pit on Black Brook, about four miles to the south-east near the point already alluded to as the turn of these measures at the end of the synclinal The occurrence of a well marked group of fossils characteristic of the productive measures in this isolated position, surrounded by miles of strata of millstone grit age, and separated from the nearest known productive coal measures by a distance of several miles, appears at first sight unaccountable. When, however, the effect of the fault already described is considered, it appears probable that in this area the millstone grit supports a narrow trough of higher strata. At present it is impossible to correllate the beds already exposed with any of those known in the Glace Bay district.

Considering the subject from the point of view expressed by Sir William Dawson, that the fossils are characteristic of the upper portion of the productive coal measures, it is difficult to believe that the lower portion of the horizon can be presented in the Cossitt Basins with the equivalents of the seams now being worked at Glace Bay; and the hypothesis may be hazarded that at this point the deposition of the later members of the strata, comprising the productive measures, took place over rocks of millstone grit age without the intervention of the middle and lower portions of the productive measures

Putting aside the fossil evidence it may be remarked that the sections exposed so far in the Cossitt Basin recall the series of small seams associated with the Martin seam near Bridgeport. It may, however, on further exploration be found that the Murray seams passing to the east of the Sydney fault out-crop along the range of the Fitzpatrick seam and coincide with the Cossitt seams as they are brought up on the opposite or west side of the fault.

VIII.—List of Plants Collected in and around the Town of Shelburne.—By George H. Cox, B. A.

(Read February 12th, 1894).

Ranunculaceæ.

Ranunculus Cymbalaria, Pursh.
" repens, Linn.
" acris, Linn.
" bulbosus, Linn. (Found in many localities about the Town.

Coptis trifolia, Salisbury. (Common in wet places, and formerly exported in large quantities for medicinal use).

Aquilegia vulgaris, Linn. (Found firmly established about "old places;" the flowers of various colors).

Berberidaceæ.

Berberis vulgaris, Linn. As a remnant of cultivation.

Nymphæaceæ.

Nymphæa odorata, Aiton. (Lake George, "The Lily Pond," &c).

Nuphar Advena, Aiton fil.

Sarraceniaceæ.

Sarracenia purpurea, Linn

Papaveraceæ.

Chelidonium majus, Linn. (Found in several scattered localities, chiefly old cellars, and no doubt adventive).

Cruciferæ.

Capsella Bursa-pastoris, Linn

Brassica nigra, Tourn. Fields; often a troublesome weed.

Cistaceæ.

Hudsonia ericoides. The Lake Road, and other places.

Violaceæ

Viola blanda, Willdenow.
" lanceolata, L. (Growing side by side with V. blanda).
" cucullata, Aiton.

Caryophyllaceæ.

Silene inflata, Smith. (Ann St., near Totty's, and other similar spots).

Spergularia rubra, of Gray (Generic name changed to *Buda* in Gray Ed. VI).

Spergularia media.

Spergula arveusis, Linn.

Sagina procumbens, Linn.

Stellaria media, Smith.

Arenaria lateriflora, Linn.

Droseraceæ.

Drosera rotundifolia, Linn.

" longifolia

Both remarkable for the excitability of the leaf-bristles; and foreign bodies resting on the leaves are found tightly bound by the recurved bristles and viscid gland-juice.

Hypericaceæ.

Elodes campanulata, Pursh. (E. Virginica Nutt.)

Hypericum perforatum, Linn.

" mutilum, L.

" Canadense, L.

Geraniaceæ

Impatiens fulva, Nuttall. (Quarry).

Oxalis stricta, Linn.

Sapindaceæ.

Æsculus Hippocastanum, L. (Some fine old trees planted here.

Acer saccharinum, Wrng.

" rubrum, Linn.

Vitaceæ.

Ampelopsis quinquefolia, Michaux. Introduced. Planted as a creeper.

Leguminosæ.

Trifolium procumbens. Naturalized.

" pratense. "

Robinia pseudacacia, L. As an ornamental tree.

Vicia Cracca, Linn.

Lathyrus maritimus, Bigelow. (Battery shore).
" palustris L. Capt. Acker's Marsh.
Cytisus Scoparius, Link. "Laughy's Clearing," and other localities, long established.

Rosaceæ.

Prunus Virginiana, Linn. Quarry.
Spiræa salicifolia, Linn.
" tomentosa, Linn.
Potentilla Norvegica, L. (Poor House Cove).
" Canadensis, L. (Battery).
" argentea, L. (Battery).
" anserina, L.
" tridentata Aiton. (Battery.)
Fragaria virginiana, Miller.
Dalibarda repens, Linn.
Rubus villosus, Aiton.
" hispidus, L.
Rosa blanda, Aiton.
Amelanchier Canadensis, T. & G.
Pyrus Americana, DC.

Crassulaceæ.

Sedum acre, L. (Escaped and long established in several situations.

Onagraceæ.

Epilobium angustifolium, Linn. (Ed. Bruce's Farm).
" palustre, L. " " "
Œnothera biennis, L.
" pumila, L.
Ludwigia palnstris, Ell.

Umbelliferæ.

Archangelica atropurpurea, Hoffm.

Araliaceæ.

Aralia nudicaulis, Linn. (Quarry).
" hispida Michaux.

Cornaceæ.

Cornus Canadensis, L.

Caprifoliaceæ.

Linnæa borealis, Gronovius.
Diervilla trifida, Mœnch. (Barracks).

Rubiaceæ.

Mitchella repens, L.
Galium trifidum, L.
" triflorum, Michaux.
Houstonia cærulea, L. (Shepherd's Bay).

Compositæ.

Ambrosia artemisiæfolia, L.
Achillæa Millefolium, L.
Leucanthemum vulgare, L.
Tanacetum vulgare, L.
Cichorium Intybus, L.
Hieracium Canadense, Michx.
Taraxacum officinale, Weber.
Leontodon autumnale, L.
Sonchus oleraceus, L.

Lobeliaceæ.

Lobelia inflata, L.
" Dortmanna, L. (Lily Pond, Lake George, &c).

Ericaceæ.

Gaylussacia resinosa, Torr. & Gr.
Vaccinium Vitis-Idæa, Linn. (Battery).
Epigæa repens, L.
Gaultheria procumbens, L.
Cassandra calyculata, Don.
Kalmia angustifolia, L.
Rhododendron Rhodora, Don.
Ledum latifolium, Aiton.
Pyrola rotundifolia, L. (Barracks).
Monesis uniflora, Salisb.
Chimapbila umhellata, Nutt.
Monotropa uniflora, L. (Quarry).
" Hypopitys, L. (Near Lake George).
Chiogenes serpyllifolia, Salisbury.

Plantaginaceæ.

Plantago major, L.
" maritima, L.
" lanceolata, L.

Plumbaginaceæ.

Statice Limonium, var. Carolinianum, Gray. (Battery).

Primulaceæ.

Trientalis Americana, Pursh.
Lysimachia stricta, Aiton.
Glaux maritima, L

Lentibulaceæ.

Utricularia cornuta, Michx. (Peat Bog).

Solanaceæ.

Datura Stramonium, L. (Escaped from cultivatiou at several points about the Town).
Lycium vulgare, Dunal. (Same remarks).

Convolvulaceæ.

Calystegia Sepium, L. (Sandy's I'd).

Scrophulariaceæ.

Verbascum Thapsus, Linn.
Linaria vulgaris, Mill. Escaped. Waste heaps, ete.
Chelone glabra, L.
Veronica officinalis, L.
Gerardia purpurea, L. (Ed. Bruce's Farm).
Melampyrum Americanum, Michx.

Labiatæ.

Teucrium Canadense, L. (Sandy's Island).
Mentha Canadensis, L
Nepeta Glechoma, Benth.
Scutellaria galericulata, L
Brunella vulgaris, L.
Galeopsis Tebrahit, L. (Poor House)

Borraginaceæ.

Symphytum officinale, L. (As escape, in a few localities),

Gentianaceæ.

Bartonia tenella, Muhl. (Ed. Bruce's Farm.)
Limnanthemum lacunosum, Griesbach. (Lake George).

Polygonaceæ.
Polygonum Persicaria, L.
" acre, H. B. K.
" aviculare, L.
Coniferæ.
Juniperus communis, L.
Orchidaceæ.
Habenaria blephariglottis, Torrey.
" tridentata, Hook, (Capt. Acker's Marsh).
" Hookeri, Torr.
" lacera, R. Br. (Shepherd's Bog).
Goodyera pubescens, R. Br.
Spiranthes cernua, Richard.
" gracilis, Bigelow.
Pogonia ophioglossoides, Nutt. (Field near Manse).
Calopogou pulchellus, R. Br. (Field near Manse).
Microstylis ophioglossoides, Nutt.
Liparis Lœselii; Richd.
Cypripediun acaule, Aiton. (Quarry.)
Iridaceæ.
Iris versicolor, L.
Sisyrinchium augustifolium, Miller.
Smilaceæ.
Smilax rotundifolia. L.
Liliaceæ.
Medeola Virginica, L. (Quarry Woods).
Clintonia borealis, Raf. (Quarry).
Maianthemum Canadense, Desfontaine. (Smilacina bifolia of Gray).
Smilacina racemosa, Desf. (R. Acker's marsh).
Pontederiaceæ.
Pontederia cordata, L. (Lake George, Mill Pond, &c).
Xyridaceæ.
Xyris flexuosa, L. (Shepherd's Bog).
Filices.
Polypodium vulgare, L. (Quarry).
Osmunda regalis, L. (Lake Rodney Brook).

IX.—Operation of the Kennedy Pipe Scraper and Cause of Recent Failure—By F. W. W. Doane, M. Can. Soc. C. E., City Engineer, Halifax, N. S.

(Read January 11th, 1894.)

On the inside of all water supply pipes which have been in use for any length of time there will be found a heavy incrustation of oxide of iron. This coating presents a very rough surface compared with the original finish. It consists of large tubercles or blisters which greatly reduce the internal diameter, and consequently the discharging powers of the pipes.

In designing a system of water works, engineers give special attention to two questions—cost and efficiency. The capacity must be sufficient for all present requirements, and the probable growing demands of the near future must not be overlooked. The question of cost fixes a limit, however, and the water mains are laid with sufficient capacity to deliver an adequate daily supply with provision for estimated increase in population and consumption during a stated period. The margin is not large, consequently it becomes a serious matter when the diameter of the pipes is reduced. The domestic supply is unsatisfactory, the pressure for fire purposes is insufficient, and unless the pipes can be cleaned, expensive renewals and alterations in the system may be necessary.

The writer has been asked frequently if the oxidation on the inner surface of a pipe would seriously affect its capacity. The piece of three inch pipe exhibited to-night answers that question beyond the shadow of a doubt. It was cut from the main on Water Street, Halifax, near the Ordnance Yard. The original diameter of three inches has been reduced to half an inch, and as the capacity decreases in the ratio of the square of the diameter, the effect on the discharging power is apparent.

Lime has been deposited in the lakes for the purpose of preventing the rapid formation of rust in the pipes, but though it may retard the formation it does not prevent it.

When the pipes are cast they are coated with coal pitch varnish to prevent rust and afford a smooth surface The following clause is taken from the specification for pipe for our new supply main:—

Coating.—"All castings shall be coated inside and outside before any rust sets in with coal pitch varnish consisting of a good and suitable coal pitch of about the consistency of tar, deoderized, and freed from its naptha and volatile constituents, and an approved fixed oil, derived from coal pitch or linseed oil, in such proportions as shall make a firm and tenacious coating. The temperature of the castings shall be about 300 degrees F. when dipped, and upon removal from the bath they shall be so dripped as to leave a coating of uniform thickness, without retained puddles or pendant drops of varnish. The varnish coating when cool shall be smooth, tough, without undue brittleness, tenaciously attached to the castings and not liable to abrasion with ordinary handling."

This varnish is scratched, cut and broken by rough handling, and, as may be seen by the specimen before you, does not prevent rust.

In Halifax an attempt was made to clean the old 3-inch pipes with hand scrapers. Sections of pipe were cut out at convenient distances and the incrustation was bored or scraped out. The cost of the work was $750 a mile, the city supplying the necessary new pipe and sleeves to make connections. This process was too slow and expensive to be adopted for the large mains. The city must not be deprived of water for more than twelve hours at one time, and in case of fire, water would be needed at short notice.

The idea of utilizing the pressure in the mains to drive scraping machines originated with Mr. J. G. Appold, M. Inst. C. E., and the apparatus was invented by him. In 1873, Mr Thomas Kennedy, the Managing Director of the Glenfield Co., Kilmarnock, Scotland, devised a modification of the Appold Scraper, and this has been in general use up to the present time.

In 1880, a Kennedy Scraper was imported from Scotland by Mr. E. H. Keating, M. Inst. C. E., then City Engineer of Halifax,

and similar scrapers have been in use in this city ever since that date. Mr. Kennedy is using them in many cities in Europe under his own supervision. Mr. Keating made an improvement in the cutter or scraper. The spring which presses the cutting edge against the pipe and the cutter itself were in one solid piece on the imported scraper. Mr. Keating made the cutter detachable, and it can be replaced when worn by use. The scrapers are made in all sizes, from six inches to twenty-four inches, and weigh from 100 lbs. to 1,000 lbs.

The principal parts of the scraper are of iron or steel. The forward end is provided with eight cutters or scrapers so arranged that the whole inside surface is cleaned by their passage through the pipe. Two pistons of sole leather serve to steady and guide the scraper and the pressure of the water against the rear piston forces the machine ahead. The normal pressure of the water under gravity in our system has been sufficient to propel the scraper without aid from other quarters.

A section of pipe is cut out at each end of the mains, leaving an opening of sufficient length to admit the scraper. The machine is inserted at the end nearest the source of supply and the pipe replaced, the joints being made with a split thimble or sleeve. When all is in readiness the water is turned on and the scraper starts off with a rumbling noise by which it can be easily followed. The rate of speed varies from one quarter of a mile an hour on a flat grade under a small head of water, or going up a hill, to one mile in ten minutes going down hill. Where there are hydrants or blow-offs they are left open and the approach of the scraper may be detected first by a current of air followed by a rush of water which has accumulated in front of the machine. The water turns to a dirty brown color and as the scraper passes it is as black as ink. The pressure then increases rapidly, and if the water is allowed to run from the hydrant it gradually becomes clear. The hydrants are usually closed at once, however, so that the pressure on the scraper may not be reduced.

Pipes should be cleaned every year, as each succeeding formation becomes harder to remove. The greatest length of pipe

cleaned at one time is on the 15 inch high service main, the distance being 29,500 feet. The run has been made in about 100 minutes and at a cost of $8.30 or 3-100 of a cent. a foot. The 24 inch low service main, 13,400 feet in length, has been cleaned for $8.23 or 6-100 of a cent a foot. The cost of cleaning 3 inch pipes by hand, the work being performed by contract, was formerly 14 2-10 cents per lineal foot.

The object of this paper is not specially to describe the operation of the scraper, as it is not a novelty. The use of the scraper has been described by Mr. James Mansergh, M. Inst. C. E. (Proc. Inst. C. E., Vol. LXVIII, p. 258; Mr. M. B. Jamieson, (Proc. Inst. C. E., Vol. LXVIII, p. 323); and Mr. E. H. Keating, M. Am. Soc. C. E, M Inst. C. E., (Trans. Am. Soc. C. E, Vol. XI, pp. 127-45.) Before discussing the cause of failure, however, it was necessary to understand clearly what it would do when working successfully.

Many who are aware that the first mile of pipe laid from Spruce Hill Lake is 20 inches in diameter suppose that it would deliver more water than the 15 inch main, with which it connects. Such is not the case, however, for the first mile is level, and the pipe has very little fall, while the 15 inch pipe falls rapidly. The smaller pipe, in consequence of the heavier grade, is capable of delivering as much water as the larger. and it is necessary to clean both pipes in order to increase the discharging power of the mains. The 15 inch pipe has been cleaned every year since 1881 with a self-propelling mechanical scraper, but only once since that date, viz., in 1885, has the oxidation been removed from the 20 inch pipe. After the incrustation has been removed once the succeeding formation is tougher and the resistance to the scraper greater. It was expected that there would be some difficulty in forcing the scraper through after a rest of seven years, and the first attempt was made through the pipe from the gate house to the hatch box at the old screen chamber, a distance of about 100 yards. The work was begun on Thursday, November 3rd, 1892, at 9.30 a. m. A coil of stout rope had been provided and was floated through the pipe so that the scraper could be

pulled out at the hatch box, if it should stop. This precaution was unnecessary, however, as it went through without any difficulty. It was again inserted and started for the run of one mile and a quarter to the junction with the 15-inch pipe. It had only gone about one hundred yards when it stopped, but in a few minutes made another short run and stuck fast. No 1 Steam Fire Engine was sent out from the city and succeeded, with the aid of water rams from the gate house, in forcing the scraper to the foot of the grade, 2,200 feet from the dam, and about one hundred yards up the hill to the edge of the bog, but at this point it stopped again and could not be dislodged. It was about daylight on Friday, the 4th, when the scraper stopped altogether, and the men were at once put at work to uncover the pipe at the joints, in order to discover, if possible, the exact location of the machine. Its progress had been so slow that it could not be followed by the usual rumbling noise. The joints were opened along a quarter of a mile of pipe and the pressure tested, but it was not until morning that the proposed location was discovered. The pipe was immediately cut and the scraper withdrawn, but it was on Saturday midnight before the pipe was again connected. It was then decided to clean the 15-inch pipe. It was with some anxiety that the scraper was started at 3.30 a.m., but it travelled more rapidly than ever before, making the run of 29,500 feet to St. Andrew's Cross in about one hour and three-quarters; and before the house-holders on the high service required it Sunday morning, water was again running freely from the taps.

The surface of Spruce Hill Lake was 11 feet above the intake. The pipe falls for 2,200 feet from the dam, where a blow-off is placed, the head being about 27 feet. From this point it rises for 2,700 feet to Scotch Hill, where an air valve is located. The pipe at this summit is on the same level as the intake, so that the pressure on the scraper would be that due to the head at the gate house minus allowance for friction, etc, which would be increased by the foul condition of the pipe. The incrustation was very heavy and the pressure was barely sufficient to propel the scraper. After passing the blow-off the scraper moved so slowly

that it could not be traced, and the water passing through it accumulated ahead of it It is necessary that some water shall pass through to carry off the dirt as it is scraped off. In this case the water could not run off ahead, and the dirt piled up. The pressure available behind could not overcome the resistance of this load of dirt and water and the scraper became lodged in the pipe.

Profiting by experience, precautions were taken last November (1893) to prevent a repetition of the trouble. The scrapers were made smaller in diameter and the pistons made tighter to prevent the passage of water. The blow-off was left open so that the pipe would be empty and the run through that portion of the main cleaned the previous year was made without any difficulty. The blow-off was closed immediately after the scraper passed so that the full pressure would be exerted on the piston. The progress of the machine was slow, as the incrustation was very thick and at times it was difficult to hear it at all. However, it continued steadily up the hill and passed the summit, reaching the end of the 20 inch pipe, 6,712 feet from the dam, in about one hour from the time of starting. No difficulty is anticipated in future, as the pipe will be cleaned every year.

X.—PHENOLOGICAL OBSERVATIONS MADE AT SEVERAL STATIONS IN NOVA SCOTIA AND NEW BRUNSWICK DURING THE YEAR 1893.—COMPILED BY A. H. MACKAY, LL. D., HALIFAX.

(Read 14th May, 1894.)

The observations recorded in the following tables are not any more complete than those of last year; but the stations of observation are more numerous, including the Province of New Brunswick as well as Nova Scotia. These tables do not represent all the work of the observers it must be noted, for the list of each was more extensive than it appears here. The observer at Kentville, for instance, made no less than 270 observations of the earliest dates of the flowering of plants, while the observer at Yarmouth made also a very large number in excess of those credited in the tabulation. The tables take those which the various observers had most in common. It is hoped that from year to year the number of observations of species common to all the stations will increase, especially as a common list has for next year been mailed each.

In the smaller table the experiment of averaging the dates for the last two years has been shown, not as something of scientific value, but as indicating the process by which a normal date can be worked out for each station and also for a province or any other district. In such a system of averaging it will be seen at once that it is necessary in order to find a normal date for the first flowering of plants or the first appearance of migratory birds for the two provinces, that we should have the several stations equally distributed over the territory, as well as the observations accurately made.

The two year normal thus worked out below is only a very rude approximation to a true normal. But the figures upon which it is based, few as they are, are recorded, and can if necessary be worked into a truer normal when desirable, by giving to stations a proper modulus. It is hoped, however, that in a few years there may be so full an accumulation of such

facts that a normal of increasing accuracy may be obtained from year to year, which normal may be used as a convenient standard for comparing the various annual variations with each other.

The observers to be credited with this work at the various stations are as follows; Yarmouth, Miss Antionette Forbes, B. A.; Berwick, Miss Ida Parker; Kentville, C. B. Robinson, Esq, B. A.; Wolfville, J. R. Herbin, Esq, Geo. Pratt, Esq., and G. D. Thomson Esq.; Gaspereaux, Jehiel Davidson, Esq.; Halifax, Harry Piers, Esq.; Truro, W. R. Campbell, Esq, B. A.; Port Hawkesbury, Miss Louisa Paint; Wallace, Miss Mary E. Charman; all in Nova Scotia. Upper Springfield, Miss Fenwick; Charlotte Co., J. Vroom, Esq.; Sunbury Co., H. F. Perkins, Esq.,; and Restigouche Co., Alex. Ross, Esq, B. A.; all in New Brunswick.

For the year 1893 the last day of each month corresponds to the day of the year here set opposite each; namely, the last day of January 31, of February 59, of March 90, of April 120, of May 151, of June 181, and of July 212. These figures will assist in the rapid mental reduction of the annual date to the common date, and *vice versa*.

PHENOLOGICAL OBSERVATIONS.

AVERAGE OF DATES COMMON TO THE TABLES FOR THE YEARS 1892 AND 1893.

SPECIES COMMON TO TABLES OF 1892 AND 1893.	Average date Nova Scotia 1892.	Average date Nova Scotia and New Brunswick, 1893.	Normal for N.S. & N.B. for 2 years.	Normal date in days of the month.
Alder, flower	102	114	108	18th April.
Aspen "	131	123	127	7th May.
Maple "	123	130	126.5	7th May.
Dog-tooth Violet, flower	135	136	135.5	16th May.
Mayflower "	98	108	103	13th April.
Strawberry "	129	133	131	11th May.
Cherry (cult.) "	146	142	144	24th May.
" (wild) "	150	144	147	27th May.
Indian Pear "	145	144	144.5	25th May.
Apple "	146	146	146	26th May.
Hawthorn "	163	160	161.5	11th June.
Lilac "	154	160	157	6th June.
Song Sparrow	99	115	107	17th April.
Robin	96	94	95	5th April.
Swallow	106	119	112.5	23rd April.
Kingfisher	128	137	132.5	13th May.
Humming Bird	143	159	151	31st May.
Night Hawk	150	144	147	27th May.
Wild Goose	54	88	71	12th March.
Frogs	105	113	109	19th April.

PHENOLOGICAL OBSERVATIONS FOR 1893,

Giving the day of the year on which the first appearances of specified said Provinces.

Number.	Flowering or Fruiting of Plants and Migration of Birds.	Yarmouth, N. S.	Berwick, N. S.	Kentville, N. S.
1	Alder *(Alnus incana)*. Catkins shedding pollen.....	103	....	105
2	Aspen *(populus tremuloides)*. " "	125	....	....
3	Red Maple *(Acer rubrum)*. Flowering...........	....	....	103
4	Adder's-tongue Lily *(Erythronium Americanum)*. Fl	....	....	....
5	Mayflower *(Epigæa repens)*. Flowering..........	....	....	....
6	Strawberry (wild), *(Fragaria Virginiana)*. Fl....	114	....	124
7	Cherry (cultivated). Flowering	....	....	133
8	Cherry (cultivated). Ripe fruit.................	....	....	....
9	Wild Cherry *(Prunus Pennsylvanica)*. Flowering.	....	....	136
10	Indian Pear *(Amelanchier Canadensis)* " ..	143	....	136
11	Apple. Flowering........................	144	....	141
12	Hawthorn *(Cratægus)*. Flowering	....	....	151
13	Lilac *(Syringa vulgarus)*. "	155	....	....
14	Wild Raspberry *(Rubus strigosus)*. Ripe fruit.....	....	....	....
15	Song Sparrow *(Melospiza fasciata)* arrived,.......	....	....	....
16	Robin *(Merula migratorius)* "	....	....	....
17	Swallow *(Tachycineta bicolor)* "	....	....	....
18	Kingfisher *(Ceryle Alcyon)* "	....	....	....
19	Nighthawk *(Chordeiles Virginianus)* "	....	....	....
20	Wild Ducks (First birds) "	....	....	....
21	Wild Geese " " "	....	....	....
22	Humming Bird *(Trochilus colubris)* "	....	....	....
23	Frogs (First heard whistling)...................	....	....	....

IN NOVA SCOTIA AND NEW BRUNSWICK,

phenomena peculiar to the seasons, were noted at several Stations in the

Number.	Wolfville, N. S.	Gaspereaux, N. S.	Halifax, N. S.	Truro, N. S.	Port Hawkesbury, N. S.	Wallace, N. S.	Up. Springfield, N. B.	Charlotte Co., N. B.	Sunbury Co., N. B.	Restigouche Co., N. B.	Average.	Average date given as day of the month.
1	135	100	113	....	....	110	....	115	99	148	114	24 April.
2	....	120	....	....	....	128	....	110	126	132	123	3 May.
3	135	135	141	133	....	....	....	130	133	....	130	10 May.
4	....	....	....	....	....	135	132	....	133	143	136	16 May.
5	103	110	100	107	105	....	119	119	104	....	108	18 April.
6	135	142	140	....	....	138	....	....	123	148	133	13 May.
7	142	153	....	142	....	....	....	....	....	....	142	22 May.
8	....	213	....	....	197	....	....	....	....	....	205	24 July.
9	....	....	153	....	....	....	....	....	....	....	144	24 May.
10	....	....	149	....	....	....	....	....	138	156	144	24 May.
11	140	155	....	....	....	152	....	....	....	....	146	26 May.
12	155	161	172	....	....	....	....	....	....	....	160	9 June.
13	152	169	....	....	....	....	....	156	160	168	160	9 June.
14	....	213	....	....	....	....	....	197	....	....	205	24 July.
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XI.—Notice of a Shower of Fibrous Substance at Gainsville, Florida.—By George Lawson, LL. D.

(Read 8th May, 1893.)

ABSTRACT.

Dr. Lawson exhibited samples of a substance, consisting of extremely delicate, pure white fibres, that had fallen from the atmosphere upon the ground in quantity large enough to whiten it over an area extending about ten miles, around Gainsville, Florida. The specimens, with an account of the phenomenon, had been transmitted by Mr. R. S. Pike, of Gainsville, to Colonel Stewart, of Halifax, in order that they might be examined with a view to an explanation of the nature and source of the substance. After examining them, Dr. Lawson wrote to Colonel Stewart as follows:—

22nd October, 1892.

Dear Colonel Stewart,—

I have examined the mass of white threads which you handed to me on the street yesterday, and which I understood you to say had fallen in a shower over a region of some miles extent in Florida. I find that the substance, on combustion, gives out an ammoniacal odour, characteristic of bodies rich in nitrogen. It cannot therefore be a vegetable fibre. It may be the silky substance of which many insects construct their cocoons. Under the microscope, however, it shows the very fine round uniform thread such as is produced by the more perfect spinning apparatus of a spider. I have no doubt therefore that such is the origin of the material. I shall be glad to hear how far this explanation accords with the observations made by your Florida correspondent.

Yours faithfully,

George Lawson.

Some months afterwards a full account of the "shower" was published in the *Scientific American*, with the results of an examination of the material, which corresponded entirely with the above explanation, and another instance of spider's web material falling from the atmosphere (in California) was cited.

Subsequent to the meeting at which the above communication was read, Dr. A. P. Reid, Medical Superintendent of the Victoria General Hospital, examined the material in question and reported upon it as follows:—

"On microscopic examination, I find it is made up of elastic fibres having much the appearance of 'yellow elastic tissue.' Each fibre is made up of a number of fibrillæ, which, on measurement of this ultimate fibril, I find it to be 0·0018 mm., or about ·000072 of an inch ($\frac{1}{14000}$). The fibrils are even and continuous and structureless. They often run in pairs perfectly parallel with each other, so much so as to bear very much the resemblance of a hollow tube, but, on careful examination, I was able to definitely resolve the apparent tube into two distinct fibrils that could be separated from each other, and they were not adherent to each other.

"This all goes to shew the accuracy of your opinion that they are the product of a spider, and each fibril the product of a "spinneret," and these spinnerets so close together that the issuing fibrils emerging in company continue to remain loosely associated. The fact that they are even, continuous and structureless will also bear out the explanation. When examined with Leitz's pantachromatics, the apparent tube is seen to be made up of as many as 3, 4 and 5 of these fibrils, lying irregularly beside one another. This can be readily made out with the $\frac{1}{8}$th objective, and with the $\frac{1}{12}$th immersion. I got the best definition with the specimen stained with Erlich's triple stain; when thus made out the structure could be preceived in the plain specimen. I have no doubt but any of the microscopic color stains would be equally efficient, and I only used the triple

because it would be more likely to shew any structure if such were present.

"The fibrils are small, the $\frac{1}{14000}$ of an inch being the largest, yet they are wonderfully even in size and continuity."

(Scientific American, Nov. 19th, 1892, page 325.)

SPIDER WEBS FROM THE CLOUDS.

A subscriber living in Gainsville, Florida, sends us for identification a white thread-like substance which he states fell to the earth in large quantities during a rain on September 20th. A sample of the material had already been forwarded by another person to the Smithsonian Institution and was thence sent to Dr. George Marx, of the Department of Agriculture, who makes the following report:

"The sample of a white substance which fell in great quantities in Gainsville, Fla., has been handed me by the botanist of this Department for examination.

"This very interesting material is without doubt a product of the spinning glands of a spider, or rather thousands of spiders The chemical reagencies prove it is not a vegetable matter, but animal, and the fact that strands can be dissolved almost infinitely into minute threads, and further, the great length of the strands, hundreds of yards, causes the inference that only a spider could manufacture it.

"The species of this spider is unknown to me, but it is not improbable that it might be a Nephila, a very large orb-weaver, which abounds in the southern parts of the United States and the West Indies.

"The young spiders of many genera avail themselves of their spinning products to migrate from their birth place by floating through the air to localities at a great distance. Should rain moisten these weavings the spider-web becomes too heavy to float in the air and sticking together in great masses falls from above.

"A similar occurrence was reported to me from Vallicita, Calaveras county, California, Nov. 16, 1891. It has occurred there for the last four years in October and November."

This is the first time this phenomenon has occurred in the South. The web is perfectly white and appears to be a mixture of silk and cotton, but mostly silk.

XII.—On the Definition of Work Done.—By Prof. J. G. MacGregor, *Dalhousie College, Halifax, N. S.*

(Received 1st May 1895.)

The usual definition of work done is the product of the magnitude of a force into the component in its action line of the displacement of its point of application. Positive work is said to be done *by* the force *on* the body on which it acts, if the force and the competent displacement have the same direction; negative work, if they have opposite directions. Positive work is said to be done *by* the body *against* the force if the force and the component displacement have opposite directions; negative work, if they have the same direction. Thus work done by the body is just work done by the force with the sign changed.

Prof. Simon Newcomb has pointed out* that as no axes of reference are specified in the above definition, the displacement referred to in it, and therefore the work done, as determined by it, are quite arbitrary. He has therefore proposed to give the definition the following form :—

"The work done by a force is the product of the intensity of the force into the amount by which the two material points between which it acts approach to or recede from each other; the work being positive when the approach or recession is in the direction of the force, negative in the opposite case."

It has been held by many writers † that the Laws of Motion require, for their complete enunciation, the specification of the axes of co-ordinates, by reference to which they hold, any such system of axes being called a dynamical reference system. If in the definition of work done also, the axes of reference which are to be employed, be specified, its arbitrary character will disappear; for by reference to given axes, any displacement will

*Philosophical Magazine, Ser. 5, Vol. xxvii (1889), p. 115.

†See Phil. Mag, Ser. 5, Vol. xxxvi (1893), p. 283.

have a definite magnitude and direction. That the definition may be adapted for use in reasoning based on the Laws of Motion, the axes employed in the definition must be the same as those by reference to which the Laws of Motion hold. Hence the usual definition will be freed from its arbitrary character and rendered capable of convenient employment in dynamical reasoning, by the following modification:—Work done is the product of the magnitude of a force into the component displacement of its point of application, in its action line, relatively to any dynamical reference system.

It will be obvious that from this modified definition, the statement which Prof. Newcomb suggests as a definition, may be deduced by the aid of the Third Law of Motion.

It will also be obvious that in the elementary study of dynamics, in which motions of small duration and extent on the earth's surface are considered, and for which lines fixed in the earth are a sufficient reference system, the young student need not be asked to employ so general a definition. For him the ordinary definition will be quite definite, as, in the first stages of study, all displacements, velocities, etc., are specified relatively to lines fixed in the earth at his place of observation, *e. g.*, the North-South line, the East-West line and the vertical.

The arbitrary character of the ordinary definition being thus removed, Prof. Newcomb's suggested modification loses its *raison d'être.* There are moreover three objections which may be urged against it—(1.) It is not a definition merely, but embodies a dynamical hypothesis as well, viz., the Third Law of Motion; and for the sake of clearness, definitions should be kept quite distinct from hypotheses. (2.) It is not a definition of the work done by a force, as it purports to be, but of the work done by a stress; and the work done by a force as distinct from the work done by a stress has been found to be a convenient conception in dynamical reasoning. (3.) It is applicable only in cases of action at a distance. In all cases of contact action, it would make the work done by a force, zero. In treating of elastic solids and fluids therefore by the contact action method, and in treating cases of apparent action at a distance on the

assumption that the distance action is due to contact action through an elastic medium, we would require to re-define work done for the purpose. It would surely be more convenient to define work done in such a way that the same conception of it might be employed in both classes of problems.

Prof. O. J. Lodge has proposed* to define work done in the following way :—

> "Whenever a body exerting a force moves in the sense of the force it exerts, it is said to do work; and whenever a body exerting a force moves in the sense opposite to that of the force it exerts, it is said to have work done upon it or to do anti-work, the quantity of work being measured in each case by the product of the force into the distance moved through in its own direction."

The definition is not quite precise; for it is not clear whether the "distance moved through" is by the body or by the point of application of the force it exerts. In cases of contact action with a view to which Dr. Lodge proposed this definition, the distance moved through by both would be the same. For his purpose, therefore, it was not necessary to be more precise. If, however, we are to form a jndgment as to the relation of this definition to the one ordinarily used, greater precision is necessary. That it was the distance moved through by the place of application of the force that was meant seems clear from the definition of working power which follows that quoted above, viz.: "The working power of a body is measured by the average force it can exert, multiplied by the range or distance through which it can exert it." The distance contemplated in the definition is thus the distance through which the force is exerted, *i.e.*, through which its point of application moves. And, indeed, had the distance contemplated been that moved through by the body exerting the force the proposed definition would have been practically equivalent to the one it was intended to displace.

To compare this definition with the usual one, let A and B be

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* **Philosophical Magazine, Ser. 5, Vol. VIII (1879), p. 278.**

two bodies between which a stress acts, let F_{AB} and F_{BA} be the forces exerted by A on B and by B on A respectively, andlet S_A and S_B be the distances moved through in the line of the stress by A and B respectively; then the work done by A and by B respectively would be, according to Lodge's definition, F_{AB} S_B and and F_{BA} S_A and according to the ordinary definition, $-F_{BA}$ S_A and $-F_{AB}$ S_B. Since in all dynamical problems the Third Law of Motion holds, we may put $F_{AB} = -F_{BA}$. Hence the work done by A and B respectively is, according to Lodge's definition, F_{AB} S_B and $-F_{AB}$ S_A and according to the ordinary definition F_{AE} S_A and $-F_{AB}$ S_B. The term work done will therefore, in general, have different denotations according to the two definitions, and consequently theorems involving work done and working-power or energy which have been established in terms of the old definition would not hold in terms of the new one. The law of the conservation of energy would no longer be generally true.

In the particular case of contact action, $S_A = S_B$. Hence in this case the work done by A and B respectively would be the same according to both definitions, and both definitions would thus have the same denotation. For cases of contact action therefore, established theorems involving work done and energy would still hold notwithstanding the change of definition.

The advantage of Lodge's definition is that in cases of contact action it indicates directly that a body in doing positive or negative work respectively, loses or gains working power, or as he puts it, that it is the thing which does the work which possesses energy. This result, however, follows from the ordinary definition by a single step. For as already seen, by putting S_A equal to S_B the work done by A and B respectively is seen to be the same according to both definitions. Any advantage which Lodge's definition offers in dealing with cases of contact action is therefore afforded by the ordinary definition as well.

If we always employed the assumption of contact action in dynamical reasoning it might be worth while to change the definition of work done in the way suggested. But whatever may be the future of this mode of treatment, we cannot at present apply it in all cases, and even in cases in which it

can be applied, it is frequently more convenient to make use of the assumption of action at a distance. Should Lodge's definition be adopted as a general definition, then in all cases in which we either must employ the action-at a-distance method or find it more convenient to do so, the simple law of the conservation of enery must be replaced by a more complex law of energy, and the labor involved in the solution of problems must be largely increased. Should it be adopted as a special definition applicable in cases of contact action, it would be necessary to employ a different definition in dealing with cases of distance action and of mixed contact and distance action, a necessity which would give rise to new difficulty in the elementary teaching of the subject and even to confusion in more advanced work.

It seems clear, therefore, with regard to both of the proposed modifications referred to above, that the better course is to retain the old definition of work done, with the dynamical reference system specified, as a general definition applicable in all cases whether of contact action, of action at a distance, or of mixed contact and distance action; and in dealing with cases of wholly distance action or wholly contact action respectively, to prove at the outset, if it be considered desirable, that the statements which Prof. Newcomb and Prof. Lodge wish to use as definitions are particular cases of the general definition, applicable, the one in cases of action at a distance, the other in cases of contact action.

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(Roman numerals refer to the Proceedings; Arabic numerals to the Transactions.)

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CONTENTS.

PROCEEDINGS.

TRANSACTIONS.

ERRATA.

Page 176, line 13; for *only*, read *on*.
" 183, " 21; insert a comma after *right side*.
" 233, " 12; read—but *a* secondary.
" 235, " 3; " – that *was* cut by.
" " " 32; " —the *upper* division of.
" 238, " 17; delete whole paragraph.
" 240, " 8; delete words—"*possibly lower carboniferous*."
" 241, " 9; read—1520 feet.
" 243, " 20; " —*downthrow;* line 24—read *names;* line 32, read—the western *is;* line 35, read—*carboniferous* near Waters hill.
" 257, " 4; " —after—south fault *west of McLellan's brook*.
" 260, " 12; for *the* read *and*.
" 261, " 5; delete whole paragraph.
" 263, " 19; for assured, read *assumed*.
" 268, " 11; read—undoub*ted*ly.
" " " 21; " —*mark*.
" 273, " 1; " —Sir W. Dawson, it is understood, strongly objects.
" 279, " 32; " —*l*ight angles.
" 292, " 29; for *for*, read *from*.
" 316, " 3; read—*overlie*.
" 324, " 16, 21; read—bitum*in*ous.
" 330, " 34; read—*120*.
" 331, " 3; for *at* read *of*.
" " " 36; read—something less, about.
" 335, " 21; " —measures *of the great East fault*.
" 336, " 23; " —where *occurs* the *coal wash*.
" 337, " 28; " —rocks *on the line of the great South fault*.
" 338, " 12; " —to connect *them*.
" 340, " 21; " – *was* at first.
Facing p. 316—Section, McLellan's Brook; read, —d. Silurian.

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